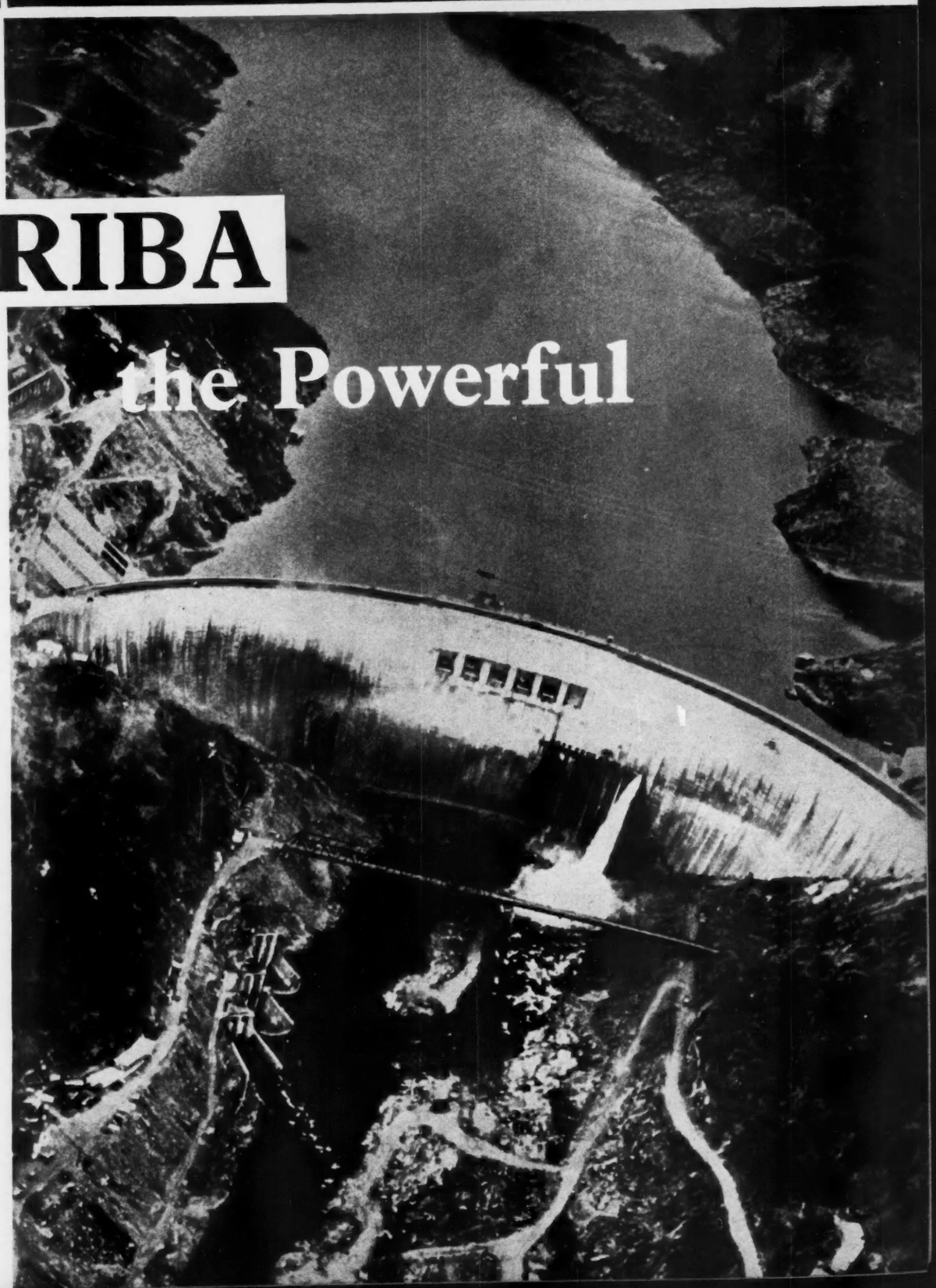
ENGINEERING

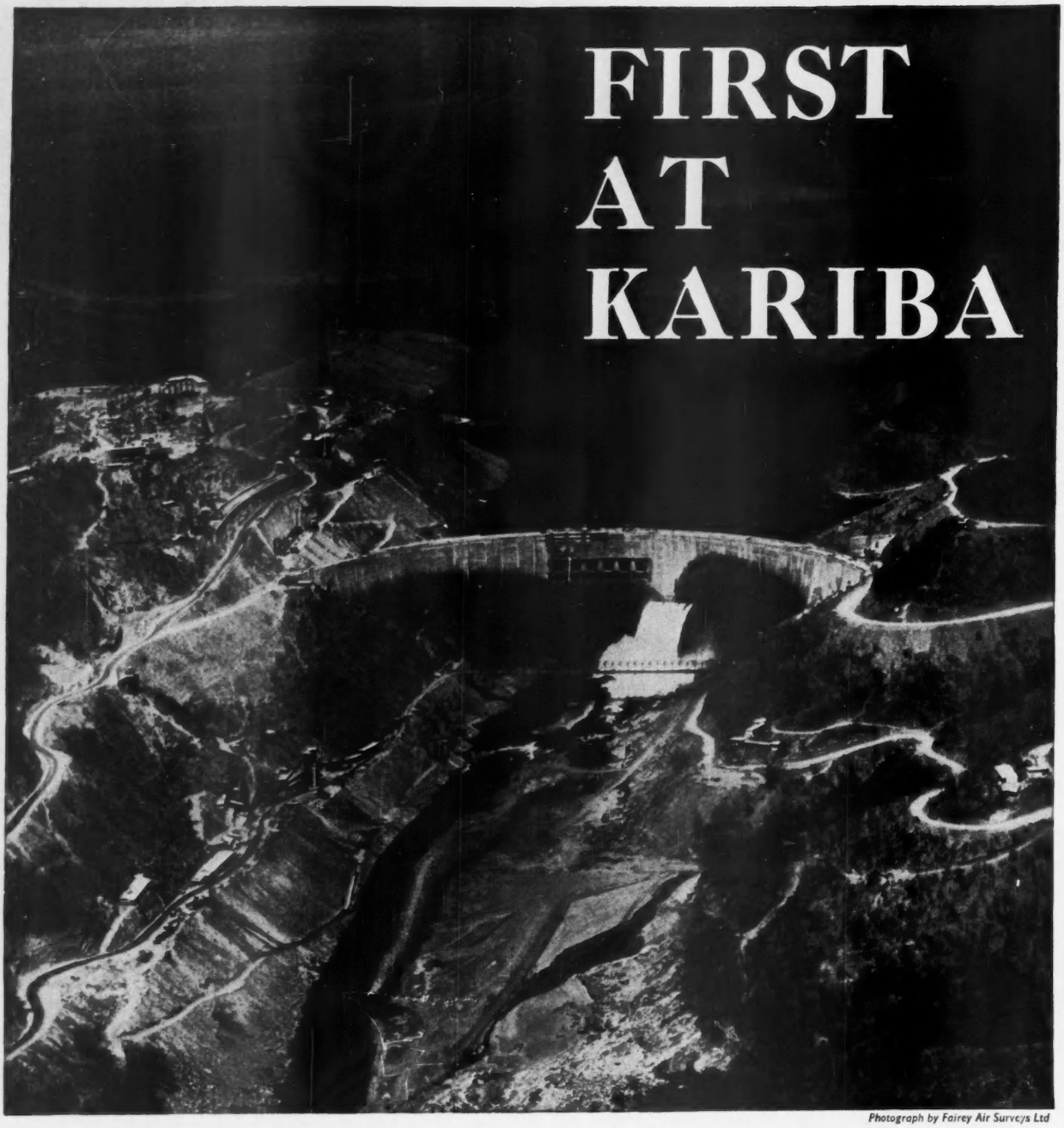
KARIBA

the Powerful



ENGINEERING reports from the site: Page 651

PRICE 2/-



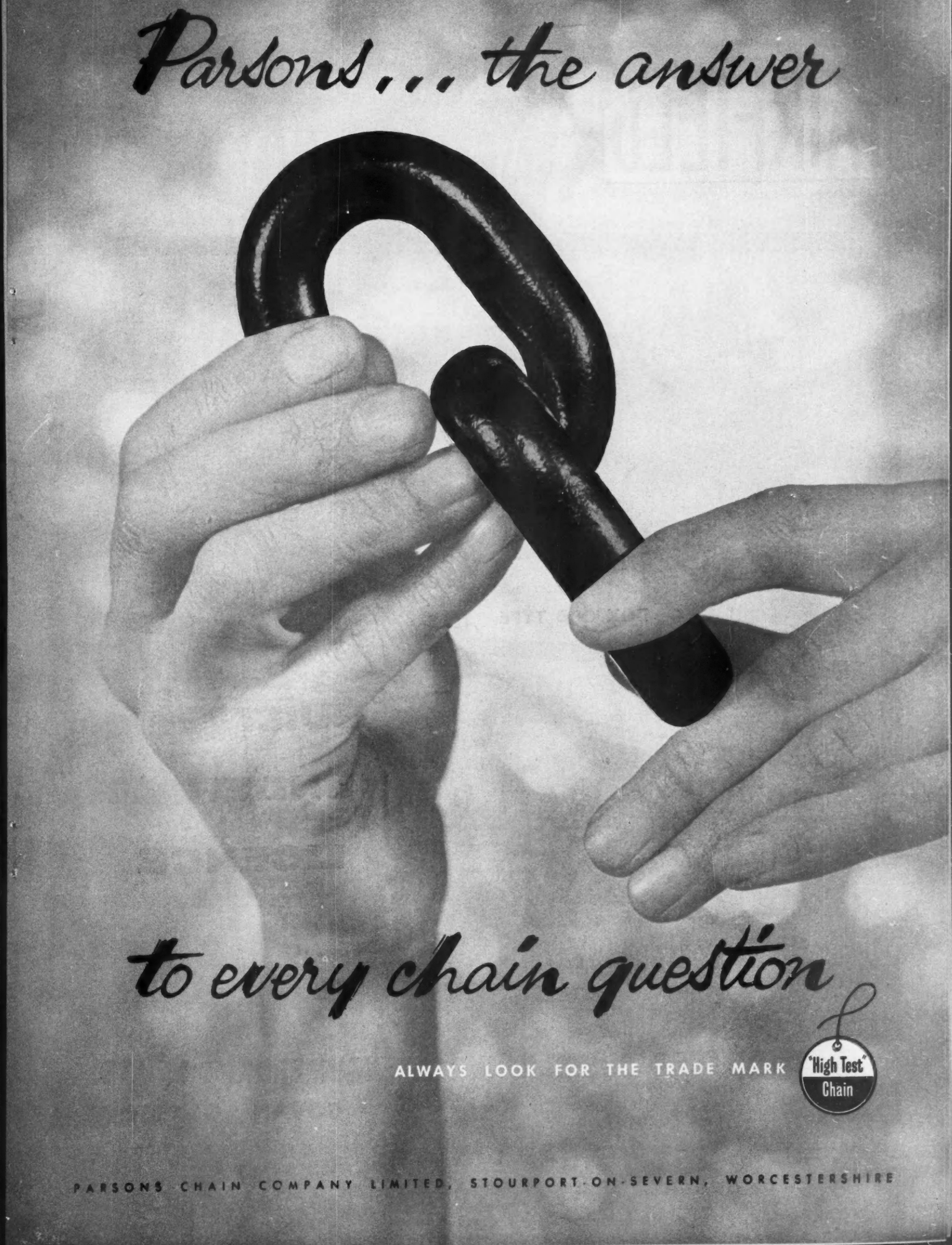
Photograph by Fairey Air Surveys Ltd

In May 1952 a handful of men, all members of The Cementation Group, travelled to Kariba Gorge. Their task was to undertake exploratory drilling of three possible sites for the Dam ☐ They were the first to arrive . . . and since that time Cementation has been responsible for speedy civil engineering at Kariba totalling £3,500,000 in value. This work includes cofferdam foundations, the driving of the diversion tunnel, and cementation of structures both above and below ground ☐ The Cementation Group is proud to have participated in this mighty project.

Cementation

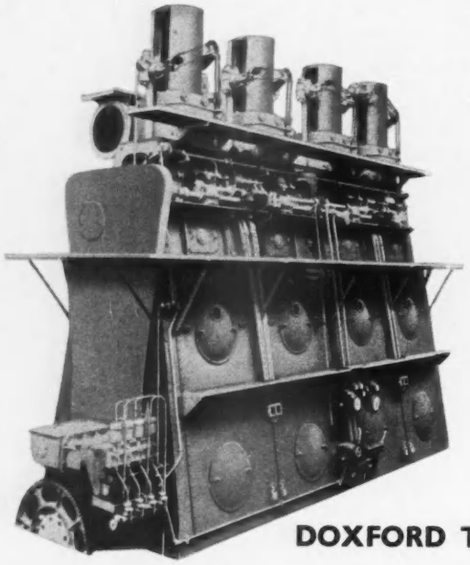
THE CEMENTATION GROUP OF COMPANIES · 20 ALBERT EMBANKMENT · LONDON SE11

And in · India · Pakistan · the Middle East · South Africa · Rhodesia · West Africa · Canada · New Zealand · Spain · Portugal · Brazil

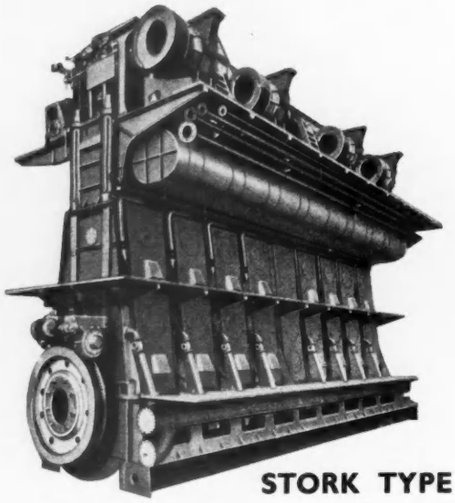

Parsons... the answer
to every chain question
ALWAYS LOOK FOR THE TRADE MARK
"High Test" Chain
PARSONS CHAIN COMPANY LIMITED, STOURPORT-ON-SEVERN, WORCESTERSHIRE

FAIRFIELD

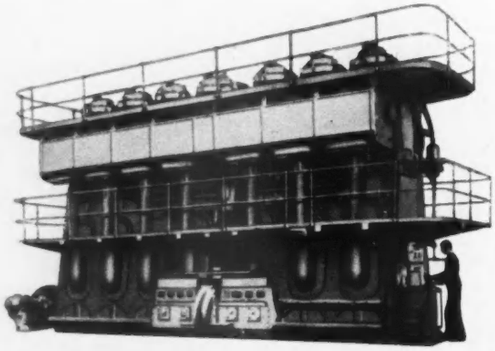
DIESEL MACHINERY



DOXFORD TYPE



STORK TYPE



SULZER TYPE

BUILT UNDER LICENCE

THE FAIRFIELD SHIPBUILDING & ENGINEERING CO., LTD.

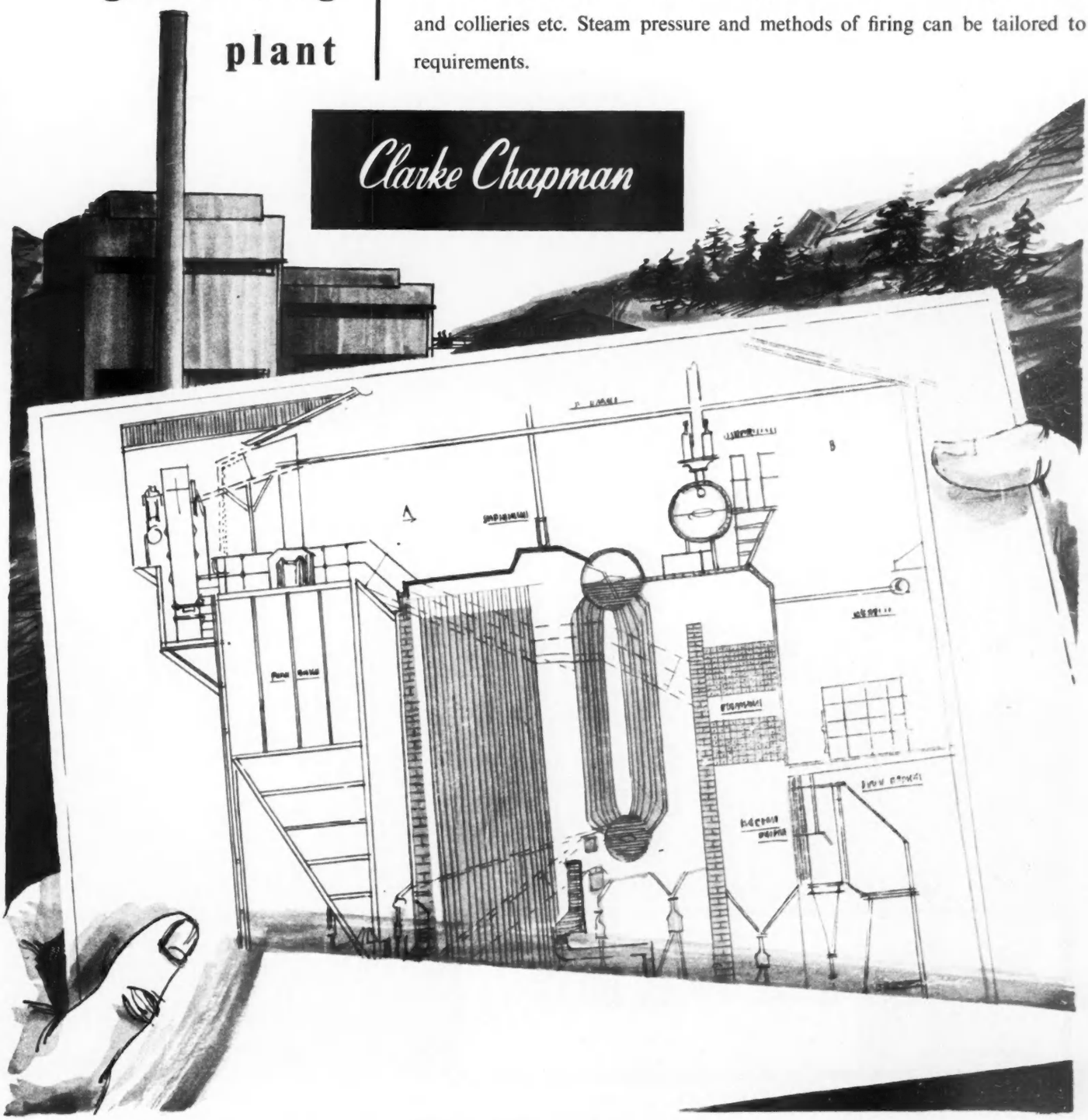
GOVAN · GLASGOW

Further order from U.K.A.E.A. for steam generating plant

AT SPRINGFIELDS we are building and installing the complete plant, comprising two stoker-fired bi-drum boilers, evaporation of 66,000 lbs/hr., steam pressure 200 lbs. p.s.i. and steam temperature 438°F, together with all civil work, buildings, coal and ash handling equipment, water treatment plant and all ancillaries.

This type of installation is ideally suitable for other industrial purposes, e.g. textile works, food processing industries, paper mills, cement works, steel mills and collieries etc. Steam pressure and methods of firing can be tailored to requirements.

Clarke Chapman



CLARKE, CHAPMAN & CO. LTD., VICTORIA WORKS, GATESHEAD, 8, CO. DURHAM. London Office: DUNSTER HOUSE, MARK LANE, E.C.3.
Glasgow Office: 116 HOPE STREET, GLASGOW, C.2. Manchester Office: 8 KING STREET, 2.

B/28

"BROOMWADE" IN BELGIUM

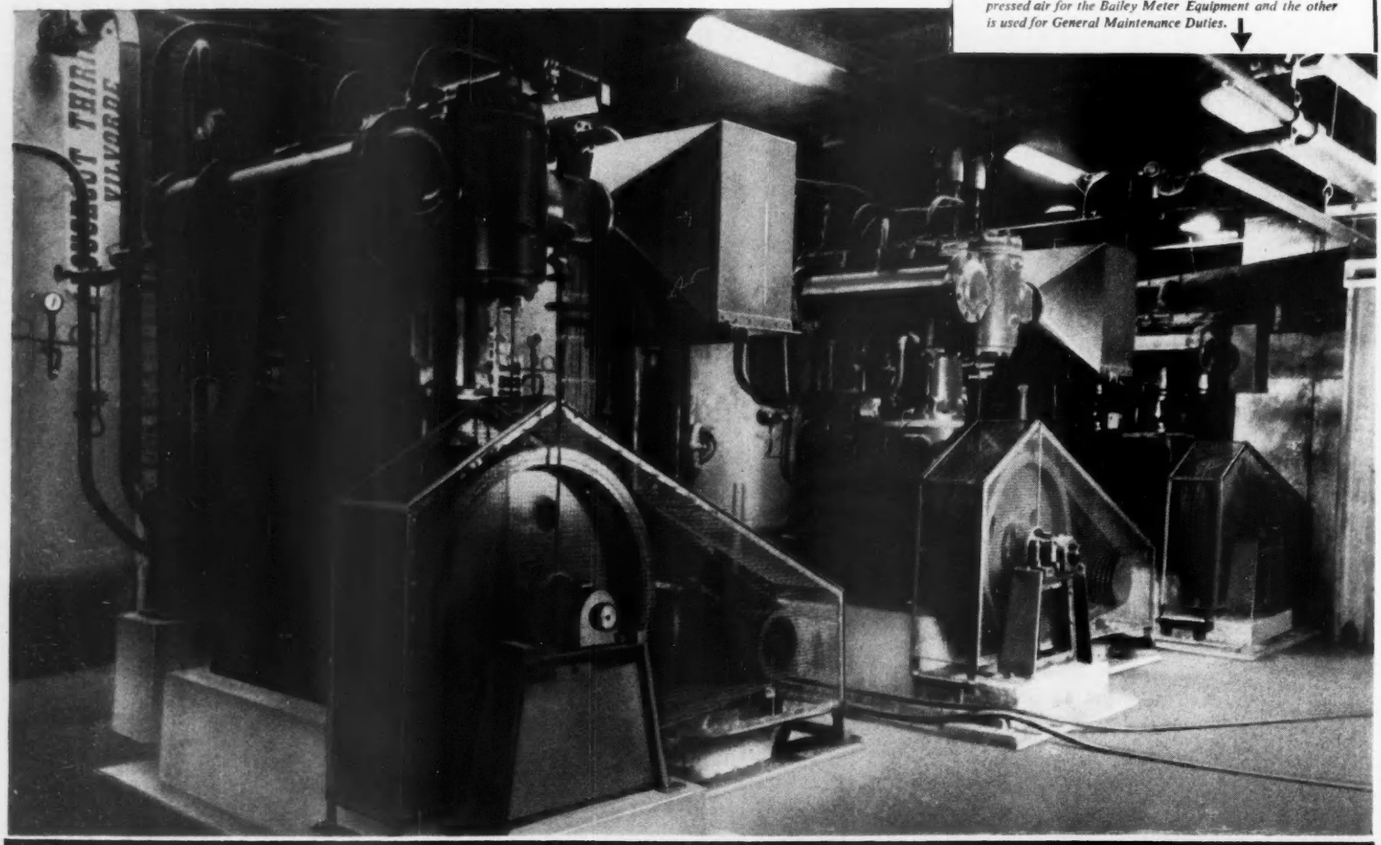
" BROOMWADE " Air Compressors and Pneumatic Tools installed in Belgium have gained a high reputation for efficiency and reliability.

Power stations at Pont-Brûlé, Ruien, Baudour, Bressoux, Farciennes, Monceau and seven other centres use " BROOMWADE " Equipment for many duties including general maintenance. " BROOMWADE " Plant is used extensively at the Mol nuclear centre.

The popularity of " BROOMWADE " Air Compressors and Pneumatic Tools has grown to such an extent that a subsidiary company, Broomwade-Belge S.A., has been formed to control the sales and servicing in Belgium, Luxembourg and the Belgian Congo. At a later date, plant will be assembled locally.

Two " BROOMWADE " Type TS1 Compressors and one TS1A installed at the Pont-Brûlé Power Station. The first two provide continuous 24-hour supply of oil-free compressed air for the Bailey Meter Equipment and the other is used for General Maintenance Duties.

Photograph by courtesy of Messrs. Interbrabant—Pont-Brûlé, Power Station.



"BROOMWADE"

Air Compressors and Pneumatic Tools

YOUR BEST INVESTMENT

BROOM & WADE LIMITED, P.O. BOX No. 7, HIGH WYCOMBE, BUCKS, ENGLAND

Telephone: High Wycombe 1630 (10 lines) Telex 15-527

751 SAS

13 May 1960

Vol. 189 No. 4908

Founded in 1866

ENGINEERING

PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone: Temple Bar 3663

Contents

651 KARIBA the Powerful—Engineering on the Grand Scale

652 Double-Curve Gives Thinner Design

653 The Big Rush to Get the Main Work Started

655 In Spite of Floods the Dam was Early

656 140,000 h.p. Turbine, 720 ton Generators

658 Transmitting the Current from Kariba

659 A High-Level Plan First

638 Metals and Materials

Fuel Oil Blended to Close Tolerances

Aluminium Based Anti-Corrosion Coating, Pvc-Coated Steel for Switch Cubicle, Combustion Additive, Plate Kit with Bright Platinum, Fire Resistant Paint Swells

642 New Plant and Equipment

Mechanical Handling Exhibition: Stacker, Mobile Crane, Charger, Electric Fork Truck, Speed Corrector

German Industries Fair: Air Cooled Diesel Engine, Small Gas Turbine, Thermostat, Thermometer, Portable Gas Turbine, Analytical Balance

662 Production

Beryllium Metal Sections in Production

Epoxide Moulds for Boat Building

664 Operation and Maintenance

Data on Reliability of Digital Computers
By J. K. Webb

Speeding Rail Freight, Lubricating Road Vehicles

669 Design

The Stress Analysis of Railway Coaches
By A. H. Lucas

Overhead Travelling Crane with Pneumatic Tyres

672 Construction

Ultimate Loads in Rock and Concrete
By T. N. W. Akroyd

Underwater Concreting at Oil Terminal Jetty, Casting a 275 kV line over a 1,000 ft Valley

674 Research and Development

Taking Steps to Measure Floor Noises
By E. G. Marklew

Marine Communications on Fifty Channels

637 Impact

645 Human Element

661 Companies

668 Marketing

Special Articles

646 Engineering Growth in Wales
By H. J. Novy

648 Mineral Wealth of Sahara Poses Problems

644 Automobile Review

Italian Cars Styled for European Markets
By Richard Bailey

649 Atomic Review

Nuclear Market

676 At Home

Scales Change—Outside

640 Plain Words

640 Letters to the Editor

Skyscrapers into Airports
H. R. Broadbent
Channel Tunnel Survey
H. Gearson
Fatigue of Welded Structures
P. H. R. Lane
Diversifying Industry in the North East
A. Stockwell
Midlands to Make More Cars
Brian Turner

641 Events in Advance

666 Publications

On the Shelf
By Frank H. Smith
Automatic Refrigeration
Refrigeration Manuals
Growth and Perfection of Crystals
Precipitation Processes in Steels
Internal Stresses and Fatigue in Metals

New Books and Trade Publications

Cover Picture

The great civil engineering work which Queen Elizabeth the Queen Mother is to inaugurate next week provides power for the developing industries of Africa. Six articles in this issue give the engineers' story of Kariba — civil, mechanical and electrical — and giving the first-hand impressions of a visiting engineer there is a report cabled from the site.

Subscription Rates: Editorial page 676

Index to Advertisements: Overleaf

Engineering Appointments Section: Faces Editorial page 660

Advertisers in 'Engineering' this week

	PAGE
A.E.C., Ltd.	18
AFSA, Ltd.	99
Alfa-Laval Co., Ltd.	13
Associated Electrical Industries, Ltd.	34, 35
Transformer Division *Wrapper*	VIII
Motor & Control Gear Division *Wrapper*	VII
Turbine-Generator Division	57
Auld, David, & Sons, Ltd.	86
Automotive Products Co., Ltd.	102
B.E.N. Patents, Ltd.	74
Babcock & Wilcox, Ltd.	46
Baker, P. W., & Sons (Sales) Ltd.	39
Beldam Asbestos Co., Ltd.	74
Blakeborough, J., & Sons, Ltd.	71
Booth, John, & Sons (Bolton) Ltd.	100
Booth, Joseph, & Bros.	6
Bostock & Bramley, Ltd.	36
Brayhead (Ascot) Ltd.	90
Brayshaw Furnaces, Ltd.	61
British Steam Specialties, Ltd.	88
British Steel Founders Association	19
British Timken: Division of The Timken Roller Bearing Co.	55
Broom & Wade, Ltd. *Wrapper*	VI
Brown David, Corpn. (Sales) Ltd.	23
Budenberg Gauge Co., Ltd.	90
Burgess Products Co., Ltd.	48
C. & M. Engineering Co., Ltd.	88
CIBA (A.R.L.) Ltd.	104
Cementation Group of Companies *Wrapper*	II
Clarke, Chapman & Co., Ltd. *Wrapper*	V
Clayton, Son & Co., Ltd.	12
Clyde Crane & Booth, Ltd.	6
Clyde Crane & Eng'g. Co.	6
Cockburns, Ltd.	54
Colt Ventilation, Ltd.	21
Consett Iron Co., Ltd.	92
Cowans, Sheldon & Co., Ltd.	74
Crane, Ltd.	72
Crofts (Engineers) Ltd.	81
Curnon Eng'g. Co.	73
Cuxson, Gerrard & Co., Ltd.	74
Daimler-Benz AG	87
Dallow Lambert & Co., Ltd.	97
Dawson & Downie, Ltd.	4
Distington Eng'g. Co., Ltd.	79
Dyson, R. A., & Co., Ltd.	13
Edwards, F. J., Ltd.	88
Empire Rubber Co.	86
"Engineering" Quickbinder	98
"Engineering" Reprints	73
English Steel Forge & Engineering Corporation, Ltd.	56
Fairfield Shipbuilding & Eng'g. Co., Ltd. *Wrapper*	IV
Fenner, J. H., & Co., Ltd.	49
Ferguson & Timpson, Ltd.	90
Ferranti, Ltd.	43
Fleming & Ferguson, Ltd.	13
Ford Motor Co., Ltd.	98
Fowler, J., & Co. (Leeds) Ltd.	82
Fraser, John, & Son, Ltd.	100
Fraser & Fraser, Ltd.	86
General Electric Co., Ltd. of England	40
Glenfield & Kennedy, Ltd.	95
Gloucester Foundry, Ltd.	10
Green, R., Ltd.	71
Greenwood's Standard Gear Cutting Co., Ltd.	102
Guest, Keen & Nettlefolds (Midlands) Ltd.	51
Harland Eng'g. Co., Ltd.	62
Harlow, Robert, & Son, Ltd.	91
Harvey, G. A., & Co. (London) Ltd.	96
Hawker Siddeley Group	101
Head, Wrightson Processes Ltd.	70
Heap, Joshua, & Co., Ltd.	38
Henderson, J. M., & Co., Ltd.	14
High Duty Alloys, Ltd.	65
Hills (West Bromwich) Ltd.	82
Holman Bros., Ltd.	17
Holroyd John, & Co., Ltd.	77
Hopkinsons, Ltd.	50
Horne Eng'g. Co., Ltd.	37
Hot Dip Galvanizers Assoc.	62
Hudswell, Clarke & Co., Ltd.	13
Hunt, R., & Co., Ltd.	37
Imperial Chemical Industries, Ltd. Degreasing Plant Division	28
Ingersoll-Rand Co., Ltd.	16
International Computers & Tabulators, Ltd.	63
International Machine Tool Exhibition, 1960	25
Jackman, J. W., & Co., Ltd.	99
Joy-Sullivan, Ltd.	89
Kidde, W., Co., Ltd.	6
LimiTorque Valve Controls, Ltd.	41
Lister, R. A., & Co., Ltd. 29, 30, 31 &	32
Madan, C. S., & Co., Ltd.	38
Mavor & Coulson, Ltd.	7
Mercer, T., Ltd.	73
Midland Heating & Ventilation Co., Ltd.	60
Minex	8
Mirrlees, Bickerton & Day, Ltd.	47
Mobil Oil Co., Ltd.	85
Mono Pumps, Ltd.	6
Morris, Herbert, Ltd.	78
Neill, J., & Co. (Sheffield) Ltd.	73
Norris Bros., Ltd.	37
North British Rubber Co., Ltd.	22
Osborn, Samuel, & Co., Ltd.	80
Parsons, C. A., & Co., Ltd.	20
Parsons Chain Co., Ltd. *Wrapper*	III
Pegler & Louden, Ltd.	99
Pilot Works, Ltd.	68
Pool, J. & F., Ltd.	99
Powder Couplings, Ltd.	38
Power Plant Co., Ltd.	5
Pulsometer Eng'g. Co., Ltd.	75
Ratcliffe, F. S. (Rochdale) Ltd.	102
Raybestos-Belaco, Ltd.	10
Reed Crane & Hoist Co., Ltd.	100
Regent Oil Co., Ltd.	83
Rice & Co. (Leeds) Ltd.	2
Riley, Robert, Ltd.	2
Robinson, L., & Co. (Gillingham) Ltd.	91
Seagers, Ltd.	100
Sealdraught, Ltd.	68
Self-Changing Gears, Ltd.	89
Sheffield Twist Drill & Steel Co., Ltd.	32
Shell-Mex & B.P., Ltd.	58 & 59
Sinex Eng'g. Co., Ltd.	8
Skefko Ball Bearing Co., Ltd.	52
Small & Parkes, Ltd.	72
Smith, J. (Keighley) Ltd.	64
Smith & Grace, Ltd.	88
Smiths Industrial Instruments, Ltd.	27 & 86
South Durham Steel & Iron Co., Ltd.	84
Spiro-Gills, Ltd.	24
Stanley, W. F., & Co., Ltd.	61
Steel Co. of Wales, Ltd.	76
Stewarts and Lloyds, Ltd.	53
Stothert & Pitt, Ltd.	103
Sunbeam Anti-Corrosives, Ltd.	25
Super Oil Seals & Gaskets, Ltd.	37
Tangyes, Ltd.	61
Tecalemit, Ltd.	45
Technoexport	94
Thermic Equipment & Eng.'g Co., Ltd.	88
Turner Bros. Asbestos Co., Ltd.	66 & 67
United Filters & Engineering, Ltd.	102
Vickers-Armstrongs (Engineers) Ltd.	15
Wallsend Slipway & Engineering Co., Ltd.	9
Ward, Thos. W., Ltd.	42
Weston, C., & Co., Ltd.	69
Whessoe, Ltd.	93
Whiffen & Sons, Ltd.	26
Wiggin, H., & Co., Ltd.	11
Wigglesworth, Frank, & Co., Ltd.	5
Winn, W. Martin, Ltd.	91
Youngs (Lifting Appliances) Ltd.	8

'Engineering' Appointments Section

inside Editorial Section	
Central Electricity Generating Board	1
Costain, Richard, Ltd.	2
Edwards High Vacuum, Ltd.	3
Laing, J. & Son Ltd.	5
Siemens—Schuckertwerke Aktiengesellschaft	3
Urwick, Orr & Ptns., Ltd.	5
Woodall-Duckham Construction Co., Ltd.	5

Classified: Trade & Technical

Edwards, F. J., Ltd.	3
Maden & McKee, Ltd.	3 & 4
Mayer, Newman & Co. Ltd.	4
Research Engineers, Ltd.	3
Shouler & Son	4
Ward, Thos. W., Ltd.	3

Company Meeting

Hoffmann Manufacturing Co., Ltd.	6

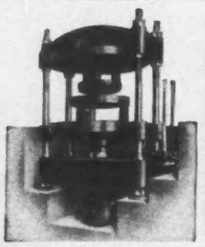
RICE-HYDRAULIC MACHINE TOOLS

Unsurpassed for riveting, flanging, forming, or any purpose for which heavy plates, sections etc., have to be manipulated and formed.

Makers of: PUMPS, ACCUMULATORS, RIVETERS, PRESSES, FOR FLANGING BENDING AND STRAIGHTENING, DEEP PRESSING, LEAD PIPE EXTRUSION, BALING STEEL SCRAP, WOOL, COTTON, Etc.

For LOCOMOTIVE BUILDERS, RAILWAY WAGON MAKERS, BOILERMAKERS, SHIPBUILDERS, TANK & GAS-HOLDER MAKERS CONSTRUCTIONAL ENGINEERS, RAILWAYS, DOCKS, STEELWORKS, Etc.

Hydraulic Flanging Press for Boiler and Tank end Plates. Several sizes. Any power.



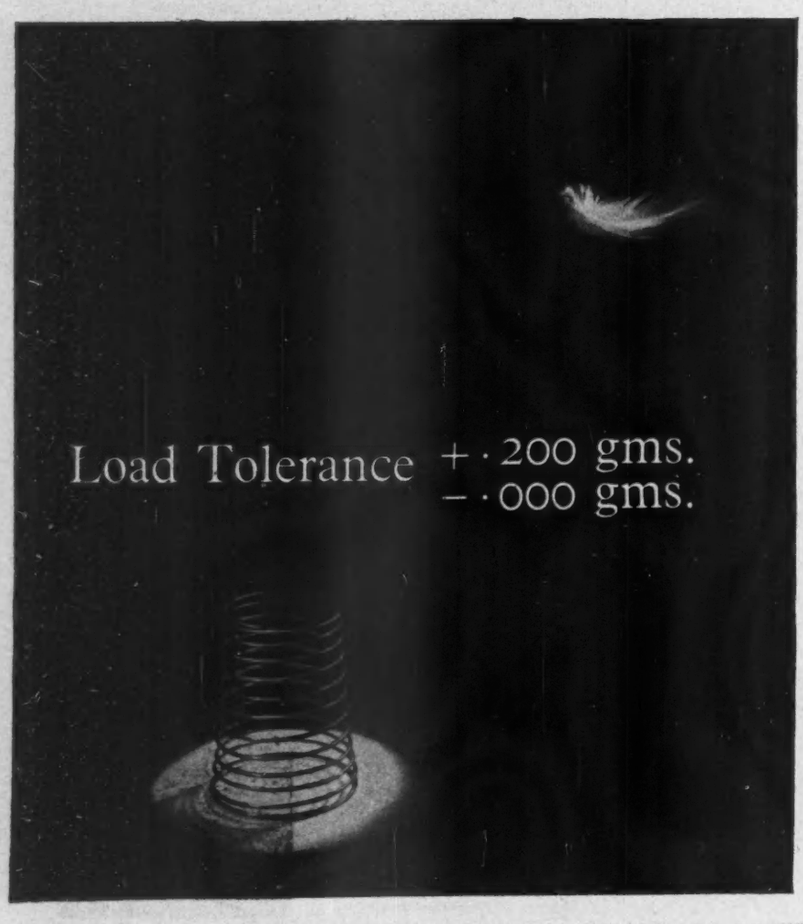
RICE & CO. (LEEDS) LTD.

HYDRAULIC ENGINEERS

LEEDS, ENGLAND

Telegrams: "PRESS, LEEDS" Telephone: 75305

Code: ABC, 5th and 6th Editions



FAMOUS FOR SPRINGS SINCE 1821

Meticulously produced to the most rigid specifications for a world-famous concern, this precision spring purpose-made by Riley has to meet precise linear dimensions under varying loads, with tolerances as low as ·200 Gms.

Such accuracy can only be achieved under the most carefully controlled manufacturing conditions. Every spring is tested (in most cases under actual working conditions and temperature) to the highest standards — Riley standards — which ensure a product of the finest uniform quality.

Springs by Riley are famous throughout the world wherever the ultimate in precision is the only acceptable qualification. Many try to reach these high standards, but few approach them.

There are no finer springs than Springs by

Riley

ROBERT RILEY LTD., MILKSTONE SPRING WORKS, ROCHDALE. *Tel: ROCHDALE 2237 (5 lines), Grams: 'RILOSPRING' Rochdale Telex 63-151*

Trade and Technical

PERSONAL

MR. JAMES M. ANDERSO is taking over from MR. BURNS, who will continue to assist him, the Scottish Agency of WILLIAM GEIPEL, LTD., for RUBBER AND THERMOPLASTIC CABLES AND ELECTRIC CONTROL GEAR. His address is 43 CHURCH ROAD, GIFFWOCK, RENFREWSHIRE. Tel. 3270. C 33

MR. L. SCULL has been appointed to represent William Geipel, Ltd., in South Yorkshire, North Midlands and Lincolnshire for rubber and thermoplastic cables and electric control gear. His address is 94, DANETHORPE VALE, SHERWOOD, NOTTINGHAM. Tel. 26-2198. C 34

CONSULTANTS & EXPERIMENTAL WORK

RE

PROTOTYPES

EXTREMELY ACCURATE PLATE CAMS

ELECTRONICALLY CONTROLLED CAM MILLING MACHINES

SPECIAL PURPOSE MACHINES

Research Engineers Ltd.,
CANONBURY, N.1.
CAN 4244/5/6
Telegrams: "Wilmaket, Nordo, London"
G 878

TENDERS

N.A.T.O. COMMON INFRASTRUCTURE

SLICE VI

NAVAL BASE INSTALLATIONS

FINAL NOTICE is hereby given that International Competitive Bids will be invited on or about the 13th July, 1960, for work in connection with the **CONSTRUCTION OF STORAGE FACILITIES** in the Dumbartonshire area of Scotland.

A Separate Final Notice will be issued in respect of the electrical and mechanical installations, which will be carried out as a sub-contract within the Main Contract.

The approximate value of the Contract will be £3,750,000, and the work will consist of the construction of reinforced concrete and other buildings, road works, railway sidings, a deep water jetty, drainage works, together with the associated electrical and mechanical installations.

It should be noted that the importation of labour from sources outside the United Kingdom may be subject to restriction and that permission could in any case be granted only on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for United Kingdom labour for the trade or industry in the same area.

The closing date for receipt of bids will be on or about 5th October, 1960.

Firms wishing to be invited to bid must formally notify their desire by application to the address below by 8th June, 1960.

Within one week of the closing date for receipt of applications to bid, firms wishing to be invited must forward the following information:—

(i) Statement of financial resources and evidence of financial stability.

(ii) Details of recent major contracts completed for work of a comparable nature including an indication of the value of each.

Enquiries regarding bidding should be addressed to:—

DIRECTOR GENERAL, NAVY WORKS,
ADMIRALTY,
CHAMBERLAIN WAY,
PINNER, MIDDLESEX,
ENGLAND,

and quoting Reference N.A.T.O. C.I. Job No. 3. C 48

SHORTLAND COUNTY COUNCIL

NEWCASTLE, NEW SOUTH WALES

SPECIFICATION NO. 7/1960

TENDER FOR SUPPLY AND DELIVERY of **4700 FT. PAPER INSULATED LEAD COVERED SINGLE WIRE ARMOURED** CABLE FOR WORKING PRESSURE OF 11,000 VOLTS AND 2100 FT. PAPER INSULATED LEAD COVERED SINGLE WIRE ARMOURED CABLE FOR 650 VOLTS WORKING PRESSURE.

Tenders are hereby invited from manufacturers in U.K. for the supply and delivery of the abovementioned Cable.

Copies of the Specification may be obtained from RANALD J. HARVEY & PARTNERS, 34 VICTORIA STREET, WESTMINSTER, LONDON, S.W.1, in payment of 5s. 0d.

Tenders endorsed "CONTRACT SCC 223" are to be sealed and delivered to the office of RANALD J. HARVEY & PARTNERS before noon on THURSDAY, 16th JUNE, 1960. C 40

CITY OF NOTTINGHAM

WATER DEPARTMENT

ANNUAL CONTRACTS—1960-61

CAST-IRON PIPES—Classes "C" and "D" (including ordinary sand cast, sand spun and spun-iron).

SPECIAL CASTINGS up to and including 6 in.—Class "CD."

SPECIAL CASTINGS over 6 in.—Class "CD."

IRREGULAR SPECIAL CASTINGS—Class "CD."

MISCELLANEOUS IRON CASTINGS. HYDRANTS AND SLUICE VALVES. GUN METAL FITTINGS.

The Nottingham Corporation invite **TENDERS** for the SUPPLY of the above stores and materials, for the 12 months ending 30th JUNE, 1961.

Copy of the General Conditions, Specifications, Forms of Tender, etc., for any of the contracts above mentioned will be forwarded on application to MR. B. W. DAVIES, ENGINEER AND GENERAL MANAGER, WATER DEPARTMENT, CASTLE BOULEVARD, NOTTINGHAM.

Tenders to be sent to me in the envelope provided not later than noon on FRIDAY, THE 27th MAY, 1960.

T. J. OWEN,
Town Clerk.

GUILDHALL,
NOTTINGHAM. C 49

THE OFFICE OF THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDINGS, BROMYARD AVENUE, ACTON, LONDON, W.3, invites

TENDERS for the following:—

(*a*) ROLLING MACHINES FOR AIRCRAFT SECTIONS.
(*b*) HYDRAULIC SKIN STRETCHING MACHINE, 60 TONS.
(*c*) STRAIGHT STRETCHING MACHINE FOR BARS AND SECTIONS.

Specifications, etc., can be obtained from the co-ordinate Branch, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3, at a cost of 10 shillings per tender enquiry and is not refundable. Tenders are to be returned to the above address by THURSDAY 2nd JUNE, 1960. Specimen copy of the above enquiries can be seen at ENGINEERING BRANCH, INDIA STORE DEPARTMENT, under the following references:—

(*a*) 2830/59/48/88B/ENG.3
(*b*) 2830/59/51/88B/ENG.3
(*c*) 2830/59/52/88B/ENG.3 C 63

THE OFFICE OF INDIA SUPPLY MISSION, 2536, MASSACHUSETTS AVENUE, N.W., WASHINGTON 8, D.C., UNITED STATES OF AMERICA, invites

TENDERS for the following:—

TENDER ENQUIRY NO. S.E.158

FOR THE SUPPLY OF ONE 75 TON (METRIC) INDOOR ELECTRIC OVERHEAD TRAVELLING CRANE SPAN 37½M. APPBOX., FOR CHANDRAPURA THERMAL POWER STATION, REQUIRED BY DAMODAR VALLEY CORPORATION.

Specifications, etc., relative to the above specification, can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of £1 15s. 8d. per tender, and is not refundable. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington 8, D.C., United States of America, so as to reach them by 19th June, 1960.

Specimen copy of the above enquiry can be seen at INDIA STORE DEPARTMENT, ENGINEERING BRANCH, BROMYARD AVENUE, ACTON, LONDON, W.3, under the following reference: 8.4226/59/NSC/ENG.2. C 62

FOR SALE OR HIRE

MASSEY 5-CWT. PNEUMATIC POWER HAMMER. Overhanging type with slides. Longest stroke 21 in. Number of automatic blows per minute 140. Anvil set at an angle to accommodate long bars. Arranged direct motor drive. Complete with anvil. Centre to back 18 in. Size of bar worked 6 in. square. Weight about 6½ tons.—F. J. EDWARDS LIMITED, 359, EUSTON ROAD, LONDON, N.W.1, or 41, WATER STREET, BIRMINGHAM 3. C 7

ADVERTISEMENT RATES

TRADE AND TECHNICAL SECTION

AGENCIES · ANNOUNCEMENTS · BUSINESS OPPORTUNITIES · CAPACITY

CONSULTANTS · EDUCATIONAL . EXPERIMENTAL WORK

FOR SALE OR HIRE · PATENTS · PUBLICATIONS

SALE AND VALUATIONS · TENDERS · TO LET · WANTED

4s. per line (minimum charge 16s.) single column inch rate 48s.

Lines average 6 words—12 lines to the inch. Box number: 2s.

SERIES DISCOUNT—5 per cent. on 6 insertions, 10 per cent. on 13, 15 per cent. on 26

DISPLAY AND ILLUSTRATED layouts are accepted

COPY DATE—first post Monday

REDUCED RATES for quarter, half and full pages—apply to "Engineering" Dept. C. A. for full information, and details of advertisements layout service.

Edwards

NEW STOELTING PLATE BENDING ROLLER. Motorised for 400-440/3/50 supply. Capacity 10 ft. by ⅜ in. Diameter of top roll 9⅝ in. Bottom rolls 7⅜ in. Rolling speed approximately 16 ft. per minute. Weight approximately 91 cwt.

CRAIG & DONALD ROTARY SHEARING MACHINE. Motorised for 400-440/3/50 supply. Capacity mild steel ⅜ in. thickness. Depth of gap 30 in. Diameter of cutters 3½ in. Weight approximately 36 cwt.

GRAYS SHEET METAL CUTTER OR NIBBLING MACHINE. Capacity ⅛ in. mild steel. Depth of throat 34 in. With automatic feed rollers and treadle operated friction clutch. Weight approximately 1,800 lb.

HORDERN, MASON & EDWARDS TYPE RTP DOUBLE SIDED, DOUBLE GEARED, DOUBLE ACTION, TOGGLE DRAWING PRESS, with rising table. Width between uprights 23½ in. Table to guides, table up 23½ in. Punch stroke 14½ in. Tee-slotted table 21 in. by 26½ in. Weight approximately 135 cwt.

FOUR BLACKBURN & CRAWSHAW POWER OPERATED GEARED ROTARY SHEARING MACHINES. Capacity ½ in. thick. Depth of gap to gauge 20½ in. Cutters' diameter thickness 5½ in. by ⅜ in. Cutting speed 51 ft. 6 in. per minute. Arranged motor drive 400/3/50.

NEW BESCO POWER OPERATED DOUBLE GEARED SWING BEAM ANGLE BENDING MACHINE. Undercrank type. Arranged motor drive for 380-420/3/50. Smallest trunk that can be formed over beam 36 in. long by 12 in. square. Capacity, mild steel 4 ft. by ⅜ in. Stroke 2½ in. Treadle operated clutch. Weight approximately 3 tons.

QUICKWORK NO. 321 MOTORISED ROTARY SHDARING MACHINE, with circle cutting attachment. Arranged motor drive for 400-440/3/50. Capacity 14 s.w.g. mild steel. Depth of shear throat 30 in. Cuts circles from 6 in. to 60 in. diameter.

Photographs of the above are available.
Very favourable Hire Purchase terms can be obtained
MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices

F. J. EDWARDS LTD.

359-361, EUSTON ROAD,
LONDON, N.W.1
Telephone: EUSton 4681-3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET
BIRMINGHAM 3.
Telephone: Central 7606-8 G 876

TWW

AIR COMPRESSORS

C.F.M.	Make	Lb. p.s.i.	Type	H.P.
300	BROOMWADE	100	EH241	75
270	BROOMWADE	100	EH240	55
210	C.P.T.	100	PB-4-210	50
200	BELLISS & MORCOM	100	—	49
200	BROOMWADE	100	D23	45
100	REAVELL	100	D8A6E	25

THOS. W. WARD LTD.

ALBION WORKS SHEFFIELD
'Phone: 26311. 'Grams: "Forward"
LONDON: BRETTENHAM HOUSE, STRAND, W.C.2
'Phone: Temple Bar 1515 (12 lines).
Remember — Ward's might have it! G 60

STEEL FRAMED BUILDINGS for sale, 8 ft. to 400 ft. clear width, as Workshop, Storage, Hangar Buildings, etc. Please write details of requirements; BELLMAN HANGARS LTD., HOBART HOUSE, GROSVENOR PLACE, LONDON, S.W.1. G 844

BLACKER TYPE B POWER FORGING HAMMER for sale. With travelling type arm. Motor drive 400-440/3/50. Treadle control blow. Length of arm 20 in. Length of travel 18 in.—F. J. EDWARDS LIMITED, 359, EUSTON ROAD, LONDON, N.W.1, or 41, WATER STREET, BIRMINGHAM 3. C 8

LATTICE STEEL ERECTION MASTS (light and heavy), 30 ft. to 150 ft. high for immediate hire.—BELLMAN'S, 21, HOBART HOUSE, GROSVENOR PLACE, S.W.1. G 72

WARD NO. 7 TURRET LATHE

Height of centres	7 in.
Between centres	27 in.
Swing over bed	14½ in. dia.
,, ,, saddle	12½ in. dia.
Bore of spindle	2⅜ in. dia.
Screwing capacity	4 to 28 t.p.i.
Chuck	4 jaw 12 in. dia.
Speeds	8 range 26 to 536 r.p.m.
Feeds (sliding and surfacing)	15 range .0036 in. to .077 in.

Inspection invited by appointment of APPLEBY-FRODINGHAM STEEL COMPANY, REFERENCE /EB, SCUNTHORPE, LINCOLNSHIRE. B 892C

STORAGE VESSELS

ALL-WELDED DISH-END

3—31 ft. by 9 ft. diam.	12,000 gallons.
2—30 ft. by 7 ft. 6 in. diam.	8,000 gallons.
3—27 ft. 6 in. by 8 ft. diam.	8,500 gallons.
2—25 ft. by 7 ft. 6 in. diam.	6,500 gallons.
1—30 ft. by 9 ft. 10in. diam.	14,000 gallons.
2—17 ft. by 5 ft. 6 in. diam.	1,750 gallons.
5—15 ft. by 4 ft. 3/5 in. diam.	1,250/1,500 gallons.
19—15 ft. by 8 ft. diam	4,000 gallons.

RIVETED, DISH-END

1—30 ft. by 8 ft. diam.	9,500 gallons.
1—22 ft. by 7 ft. 6 in. diam.	6,050 gallons.

RIVETED, FLAT-END

3—30 ft. by 8 ft. diam.	9,500 gallons.
1—30 ft. by 7 ft. 6 in. diam.	8,000 gallons.
1—24 ft. by 7 ft. 6 in. diam.	6,600 gallons.

RECTANGULAR, ALL-WELDED

1—28 ft. by 10 ft. by 9 ft. deep	15,750 gallons.
1—15 ft. by 6 ft. by 5 ft. 3 in. deep	2,500 gallons.
1—14 ft. 3 in. by 5 ft. 3 in. by 6 ft. 3 in. deep	2,500 gallons.

MADEN & McKEE, LTD.,
317, PRESCOT ROAD,
LIVERPOOL, 13. B 980

PRESSURE VESSELS

16—All-welded D.E., 14/15 ft. by 8 ft. diam.	65 lb. w.p.
2—All-welded D.E., 27 ft. by 7 ft. 6 in. diam.	75 lb. w.p.
3—All-welded D.E., 9 ft. 4 in. by 2 ft. 6 in. diam.	210 lb. w.p.
1—All-welded D.E., 17 ft. by 5 ft. 6 in. diam.	200 lb. w.p.
2—Riveted D.E., 27 ft. by 6 ft. diam.	365 lb. w.p.
3—Riveted F.E., 30 ft. by 8 ft./8 ft. 6 in. diam.	100/120 lb. w.p.

MADEN & McKEE, LTD.,
317, PRESCOT ROAD,
LIVERPOOL, 13. B 981

M.S. PIPING

6 in. nom. bore up to 18 ft. lengths.
8 in. nom. bore up to 18 ft. lengths.
10 in. nom. bore up to 24 ft. lengths.
12 in. nom. bore up to 36 ft. lengths.

MADEN & McKEE, LTD.,
317, PRESCOT ROAD,
LIVERPOOL, 13. B 975

For 'Engineering' Appointments Section, turn to the centre of editorial section.

TRADE AND TECHNICAL
CONTINUED

STEEL SECTIONS AND PLATE

M.S. ANGLE
1½ in. by 1½ in. by ¼ in. by 8 ft. long.
2 in. by 2 in. by ¼ in. by 15 ft. long.
4 in. by 3 in. by ⅜ in. up to 25 ft. long.
6 in. by 6 in. by ½ in. up to 30 ft. long.

R.S. CHANNEL
6 in. by 3½ in. by ¼ in. up to 40 ft. long.
7 in. by 3 in. by ¼ in. up to 26 ft. long.

R.S. JOISTS
5 in. by 3 in. by 13 ft. long.
6 in. by 3 in. by 12 ft. long.
7 in. by 4 in. by 13 ft. long.
14 in. by 6 in. up to 26 ft. long.
Large stock of sections up to 22 in. by 7½ in. in random lengths.

R.S. STANCHIONS
6 in. by 5 in. by 14 ft./15 ft. 3 in.
8 in. by 6 in. by 14 ft./15 ft.

MADEN & McKEE, LTD.,
317, PRESCOT ROAD,
LIVERPOOL, 13. B 977

STEEL MAINS

116 ft.—16 in. Welded Steel Flanged Mains.
96 ft.—18 in. Welded Steel Flanged Mains.
49 ft.—24 in. Welded Steel Flanged Mains.
250 ft.—36 in. Welded Steel Mains, plain ends.
MADEN & McKEE, LTD.,
317, PRESCOT ROAD,
LIVERPOOL, 13. B 978

STEEL TUBING

110 ft.—8½ in. bore by 9½ in. o.d. Steel Tubing. Unused, stock rusty.
MADEN & McKEE, LTD.,
317, PRESCOT ROAD,
LIVERPOOL, 13. B 979

STEEL, ALUMINIUM, BRASS, SHEET AND OFFCUT, 10 to 24G. Small or large quantities. Cash payment—DYAS & FOWLE. 41, LOUDOUN ROAD, N.W.8. MAL 2711, 5477, G 662

WANTED

CLEARING LINES OR REDUNDANT STOCKS of every description required.—C. ROSE, 106, HENDON WAY, LONDON, N.W.2, or Telephone: SPEedwell 3625. C 3

DISMANTLERS

For factory dismantling the
MAYER, NEWMAN SYSTEM
Scrap Iron & Steel Clearance
MAYER, NEWMAN & CO. LTD.
Arundel House, Arundel Street, London, W.C.2.
Telephone : **TEMple Bar 9711.** G 850

AGENCIES

NORTH OF ENGLAND SALES ORGANISATION having good connections with Shipbuilders, Marine Engineers, Steel Manufacturers, Chemical Industry and Collieries, desires **FIRST CLASS AGENCIES** for Heavy Engineering Materials and Equipment. Manufacturers who are interested should apply to BOX G 831, Offices of ENGINEERING, when advertiser will give serious consideration to their offers.

WORK WANTED

PRATCHITT BROTHERS, LTD., DENTON IRON WORKS, CARLISLE, having well equipped engineering shops and iron foundry, **INVITE ENQUIRIES FOR GENERAL ENGINEERING, STRUCTURAL AND PLATEWORK,** from firms wishing to have plans made to their own designs and specifications. G 555

PATENTS

THE PROPRIETORS OF PATENT NO. 766193 for "IMPROVEMENTS IN OR RELATING TO PUMPS FOR LIQUID OR GASEOUS MEDIA" desire to secure commercial exploitation by Licence or otherwise in the United Kingdom.—Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. B 964

THE PROPRIETOR OF PATENT NO. 767886, for "IMPROVED ADJUSTABLE NOZZLE FOR HOSES OR SPRAYS," desires to secure commercial exploitation by Licence or otherwise in the United Kingdom.—Replies to Haseltine Lake & Co., 28 SOUTHAMPTON BUILDINGS, CHANCERY LANE, LONDON, W.C.2. C 38

SALES & VALUATIONS

SHOULER AND SON

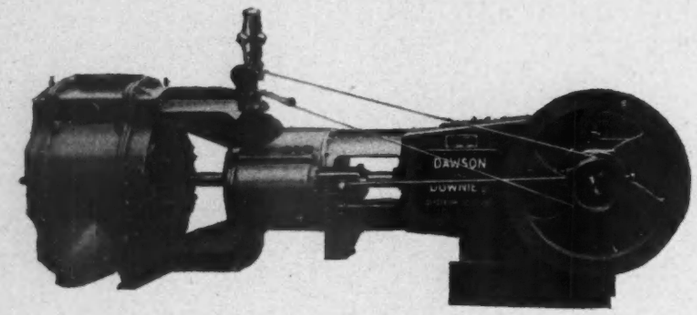
By order of the E. R. Secretary of State for War

SALE BY AUCTION AT
MELTON MOWBRAY
(15 miles from Leicester; 18 Nottingham; 16 Grantham; 20 Stamford)
of
MACHINE TOOLS; WOODWORKING MACHINERY; BALING PRESSES; ELECTRICAL TEST INSTRUMENTS; BOOT AND SEWING MACHINES; TRAILER VANS
now lying at
TECHNICAL STORES DEPOT, OLD DALBY
(6 miles from Melton; 12 Nottingham; 15 Leicester; and near Old Dalby L.M.S. Railway Station)
including:
Pneumatic Hammers; K. & W. Radial Drills; Jones & Shipman Universal Precision Grinder; Centre Lathes, 3½ in. to 9 in.; Pillar and Bench Drills; Heavy Duty Shearing and Punching Machine; Hacksaw; Arc Welder; Vertical Baling Presses; Fuel Injector Lapping Machines; Steam Cleaners; Tool Grinders; B.O.C. Welding Equipment including Pantograph Profiling Cutting Machines; Engraving Machine; Hardness Testing Machines; Pultra Instrument Lathe; Valve Refacers and Valve Seat Grinders; Woodworking Machinery:—Universal Woodworkers; Planers and Thicknessers; Chain and Chisel Morticers; Circular Saw Benches; Dimension, Chain and P. El. Saws; Turning Lathe, Borer, Plane Grinder; Port El. Drills, Grinders, Sanders, Screwdrivers; Guillotines, Washing Pump; Hearths and Forges; 400 kVA Transformers; Dehumidifying and Temperature Refrigeration Equipment with air compressors; 22 kW Diesel Generating Set; 14 Trailer Vans; Boot Repair Machines; Photographic Equipment; Electrical Test Equipments.
Which will be sold by Auction by
SHOULER AND SON
on FRIDAY, 10th JUNE, 1960
at 10.30 a.m. prompt.
AT THEIR AUCTION ASSEMBLY ROOMS, 1 NORMAN STREET, MELTON MOWBRAY.

ON VIEW: Thursday, June 2nd, Wednesday and Thursday, June 8th and 9th, from 9.0 a.m. to 4.0 p.m. and on morning of Sale, 8.30 a.m. to 10.30 a.m.

CATALOGUES, 1s. each (P.O. only, no stamps). Obtainable from the Auctioneers (Dept. 15), 1 and 3 Norman Street, Melton Mowbray. Tel. 3081 (two lines). C 30

VACUUM PUMPS

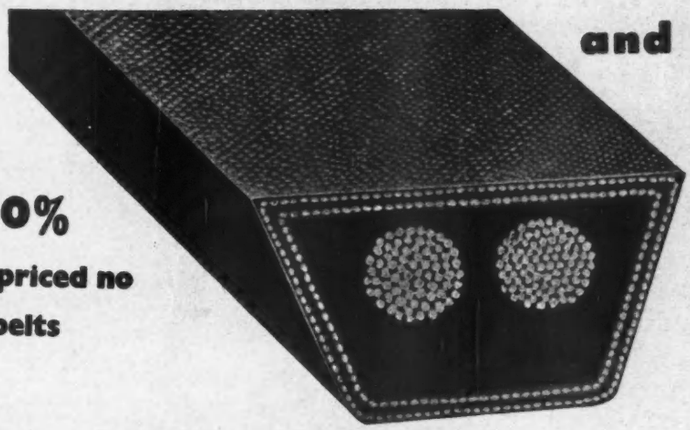


Dawson & Downie Dry Vacuum Pumps, fitted with steam or electric drive, are capable of maintaining a high degree of Vacuum.
Single stage dry slide valve pumps can maintain vacuum of 0·2 in Hg Barometric Reading against a closed suction valve. Double Stage type can maintain vacuum of 0·02 Hg.
Illustrated on the left is a Dawson & Downie single stage dry air pump with 36in. diameter air pump cylinder, 18in. diameter steam cylinder and 18in. stroke.

Dawson & Downie Ltd

ELGIN WORKS CLYDEBANK SCOTLAND
Telephone : Clydebank 2271/2/3 Telegrams : "PUMPS" Clydebank

There's a *Big Difference*

between this  and any other V-belt

LAST 20 to 50% LONGER... Yet priced no higher than ordinary belts

TEXROPE Grommet V-Belts

ALL BRITISH
TEXROPE GROMMET
V-BELT DRIVES
MANUFACTURED
AND SOLD ONLY BY

FRANK WIGGLESWORTH & CO LTD

SHIPLEY YORKSHIRE
'Phone : SHIPLEY 53141
Grams : CLUTCH, SHIPLEY

---

*
*
*

Whatever your transmission problems we design gears for any power—any speed.

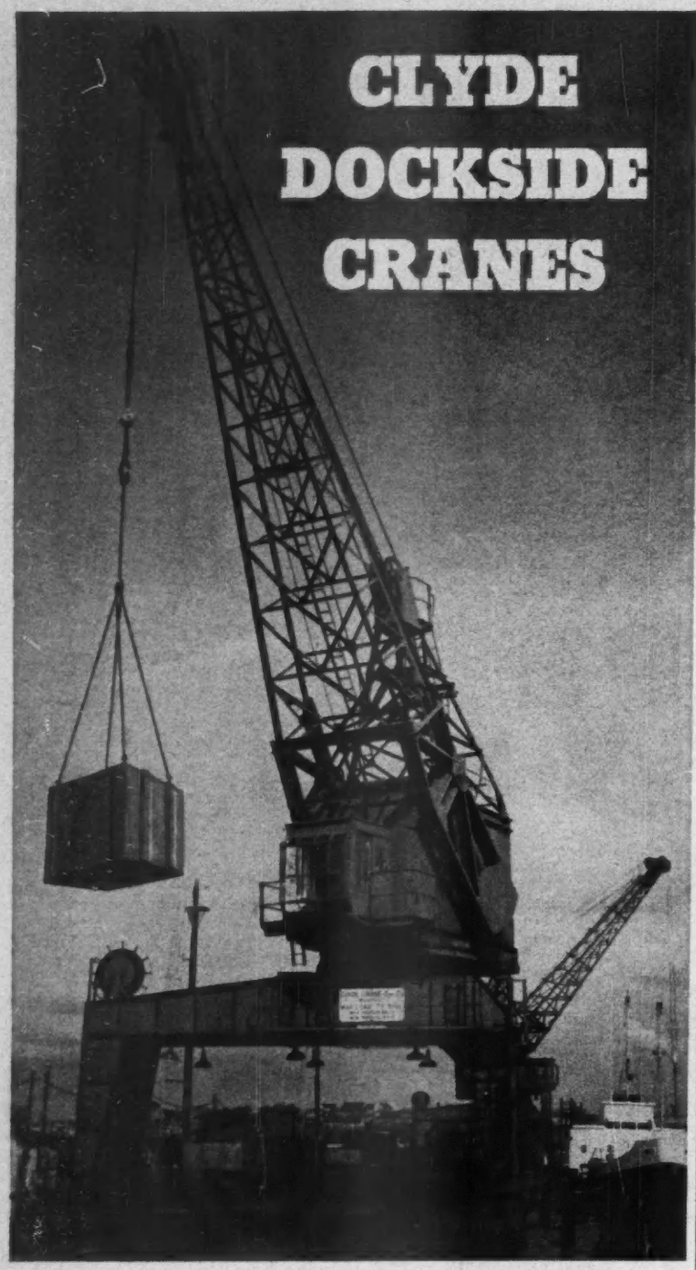
More than 50 years of specialised experience at your service.

*
*
*

THE POWER PLANT COMPANY LIMITED

WEST DRAYTON, MIDDLESEX TEL: WEST DRAYTON 2626 (4 lines) GRAMS: ROC. WEST DRAYTON

CLYDE DOCKSIDE CRANES



INCORPORATING . . . . . .

C.C. & B. LOW PRESSURE HYDRAULIC LUFFING

The Clyde Hydral-Luff is an electric crane having the jib operated by an electro-hydraulic transmission system. It has established new standards of smoothness, reliability, and operational speed for many ports. Built for hard work, long life and ease of maintenance, the Hydral-Luff could well reduce your handling costs. *May we furnish you with further details?*

Send for the Clyde Hydral-Luff Booklet.

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD.

Incorporating:

Clyde Crane & Engineering Co., Mossend, Lanarkshire

Tel. Holytown 412 (6 lines) Grams: 'Clyde Motherwell Telex' Telex 77443

and

Joseph Booth & Bros., Union Crane Works, Rodley, Leeds

Tel. Pudsey 3168 (6 lines) Grams: 'Cranes Rodley Telex' Telex 55159

WHAT IS A FELLMONGER?

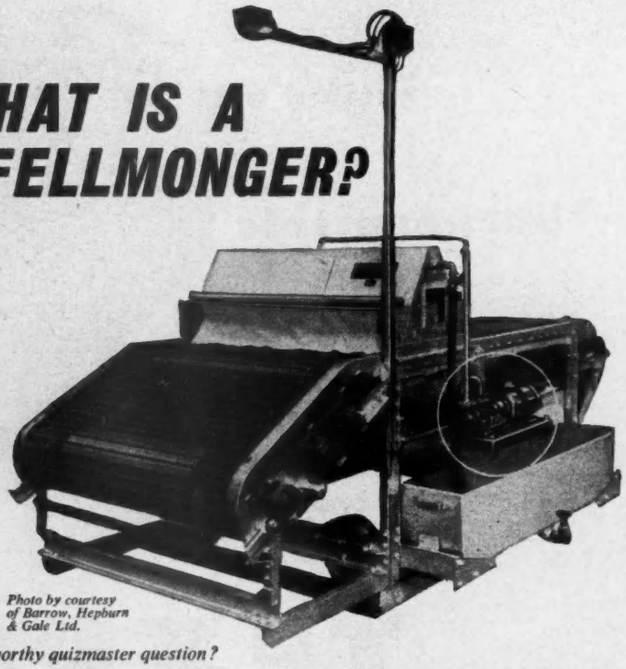


Photo by courtesy of Barrow, Hepburn & Gale Ltd.

A worthy quizmaster question?

When supplying a pump for dealing with Sodium Sulphide/Lime Paste we knew a good deal about pumping the paste, but a little puzzled about Fellmongers. But there is the Mono Pump tucked away on a machine for fellmongers who prepare woolled sheepskins. Only one of the many, many duties performed by Mono Pumps on many machines, in many factories, on many processes —commonplace or outlandish.

The MONO pump

MONO PUMPS LTD. MONO HOUSE, SEKFORDE ST. CLERKENWELL GREEN, LONDON, E.C.1.

Tel: CLErkenwell 8911 *Grams: Monopumps Phone London*

United Kingdom Branches. Belfast, Birmingham, Bristol, Glasgow, Manchester, Newcastle and Wakefield and Overseas: Dublin, Durban, Johannesburg, Melbourne and Sydney.

17P318

Those who have the experience to judge the best BUY KIDDE

Kidde

EXPERIENCE . . . whenever there is a fire—be it in Industry, on an airfield or in a ship afloat—there is a new lesson to be learned; new clues to more rapid detection and suppression to be gleaned. The Walter Kidde Company, analysing these clues, is constantly adding to its unrivalled experience in fire detection and suppression.

Experience proves the necessity of detectors specifically suited to the nature of the risk. Kidde's range of over a dozen different detectors—with operating principles ranging from thermocouple to ultrasonic, from pneumatic to infra-red —enable experienced Kidde engineers to specify the best detectors for every type of risk.

Kidde Extinguishing Systems:

Specialists in inert gas extinguishing systems using carbon dioxide, nitrogen, CF_3BR, products of combustion, and argon.

THE WALTER KIDDE COMPANY LIMITED

Northolt, Middlesex. Telephone: VIKing 6611.

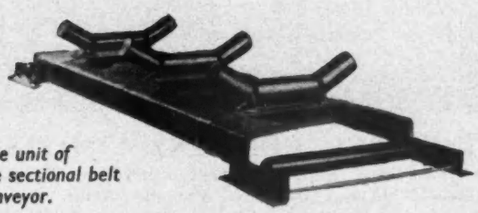
Kidde have overseas manufacturing facilities in: The U.S.A., Argentina, Australia, Brazil, Canada, France, Germany, Italy, Japan and Mexico. Over 500 recharging Service Stations throughout the world.

From over the skyline, from down in the dip beyond,
from far away on the next rise, M&C conveyors bring the gravel
from excavators to plant. The distance
in this case is rather less than a mile; in others it is more.

for long hauls—
M&C conveyors

Gravel arriving at a plant near Colchester.

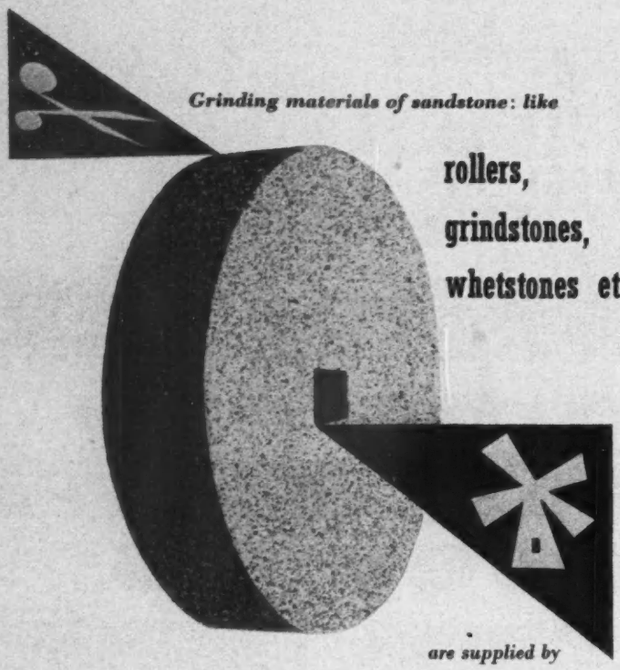
Good conveyor lines are easily built of M&C structure.
M&C idlers make the utmost of the belts. These idlers are
sealed for long life, so that even
after years of battling with dust and rain
they still spin at a touch. Ask for booklet 703A



One unit of the sectional belt conveyor.

MAVOR & COULSON LTD

Bridgeton Glasgow S.E.
Olive Grove Road Sheffield 2
36 Victoria Street London S.W.1



Grinding materials of sandstone: like

rollers, grindstones, whetstones etc.

are supplied by

THE SOLE EXPORTER OF MINERALS AND MINERAL PRODUCTS

MINEX

WARSZAWA, Krakowskie Przedmiescie 79, POLAND

Cables: MINEX WARSZAWA

Telex: 10416 and 10417 minex wa

P.O. Box 54

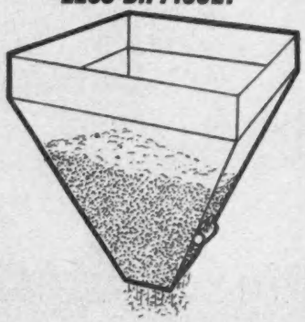
HYDRAULIC RAIL BENDER (REGISTERED PATTERN) FOR BENDING SIDEWAYS ACROSS THE FULL DEPTH OF RAIL. FOR ALL SIZES OF RAILS UP TO No. 11, BS SECTION 126 LBS/YD AND 150 LBS/YD CONDUCTOR RAIL.

Write for List No. Ry1157

YOUNGS (LIFTING APPLIANCES) LTD

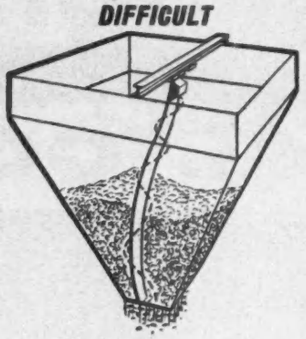
RYLAND STREET WORKS, BIRMINGHAM, 16. Tel.: EDGbaston 3508-9 Grams: OLDENS B'HAM

LESS-DIFFICULT



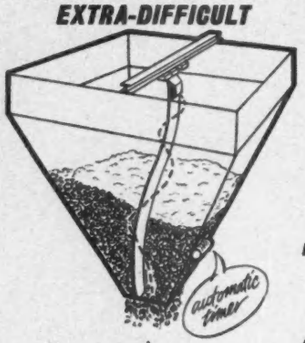
The installation of an external vibrator to a steel hopper.

DIFFICULT



The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.

trouble-free bunker discharge

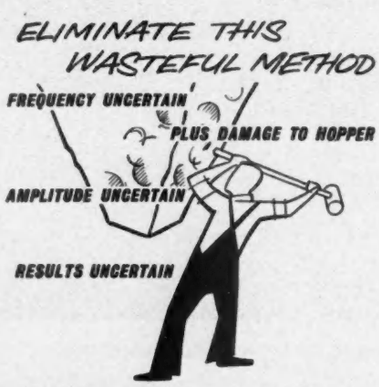
The primitive, inefficient method commonly used for clearing material which sticks in a storage bunker is by applying a sledge hammer to the side of the hopper. This is a form of low frequency, uncontrolled vibration. When vibration is applied at the *correct* frequency, the *correct* amplitude and the *correct* point of application, almost any material can be satisfactorily discharged.

SINEX has the experience with a wide variety of materials and a wide range of hopper designs to recommend how vibration should be applied effectively to solve *your* particular problem.

The three examples illustrated show three different combinations which are typical of many applications, but even these, whilst using the same type of unit, can only be effective if the types of unit themselves are placed in the correct position and have the correct frequencies and amplitudes of vibration, to suit the characteristics of the material to be discharged.

It would pay you, therefore, to make use of our experience and to consult us on your particular problem.

Send for relevant details and information sheet.



These are some of the many materials which we have handled satisfactorily and ensured trouble-free bunker discharge: Pulverised and small coal, iron ore, coke, lime, flour, grain, grist, foundry sand, soda ash, cullet, sand, gravel, granite chips and all road stone materials.

Sinex

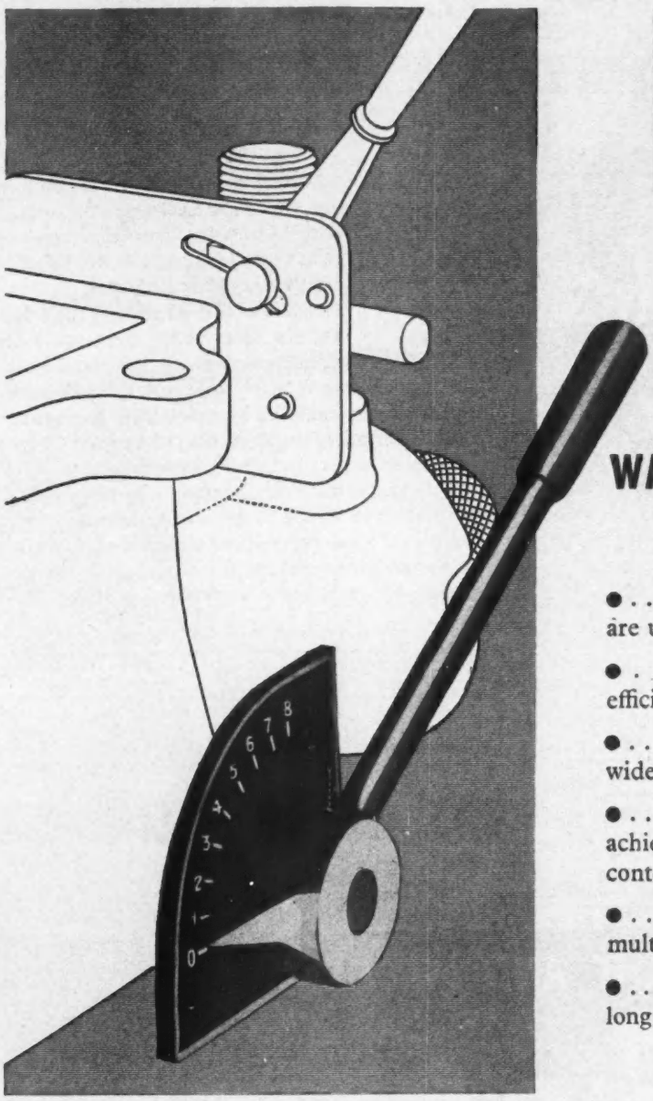
Bunker clearance Equipment

SINEX ENGINEERING COMPANY LIMITED

Centra Way, North Feltham Trading Estate, Feltham, Middlesex.

Telephone: Feltham 5081 (5 lines) Telegrams: Sinexvibro Feltham.

ASSOCIATED COMPANIES IN PARIS BRUSSELS AND ZURICH.



The Burner shown has a maximum output of 12 gallons per hour and requires atomising air at 20" (51 cm) w.g. to 30" (76 cm) w.g. with oil at not less than 5 lbs per sq. in. (0.35 kgs. per sq. cm.) or equivalent head.

Made to Measure

WALLSEND SELF-PROPORTIONING LOW AIR PRESSURE BURNER

- . . specially designed so that the fuel output and air/oil ratios are under complete control.
- . . provides fingertip, single lever control for accurate and efficient regulation.
- . . automatically ensures a correct mixture of air and oil over a wide range irrespective of the type of fuel in use.
- . . has a turn down range of approximately 5 : 1 which can be achieved with a stable flame, efficient combustion and a high CO_2 content.
- . . leads the way to automatic or remote control of single and multi-burner installations.
- . . incorporates the well known Wallsend features of robustness, long service with little maintenance, and flexibility.

For more efficient

OIL BURNING

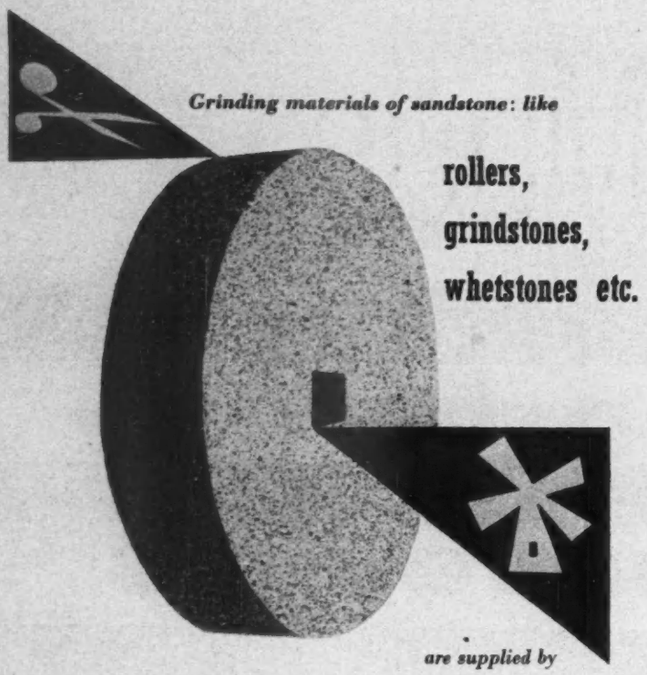
consult

THE WALLSEND SLIPWAY & ENGINEERING COMPANY LIMITED

WALLSEND-ON-TYNE

NEARLY 80 YEARS OF OIL BURNING EXPERIENCE

In association with **HUBBARD COMBUSTION LIMITED, Kingston on Thames**



Grinding materials of sandstone: like

rollers, grindstones, whetstones etc.

are supplied by

THE SOLE EXPORTER OF MINERALS AND MINERAL PRODUCTS

MINEX

WARSZAWA, Krakowskie Przedmiescie 79, POLAND

Cables: MINEX WARSZAWA

Telex: 10416 and 10417 minex wa

P.O. Box 54

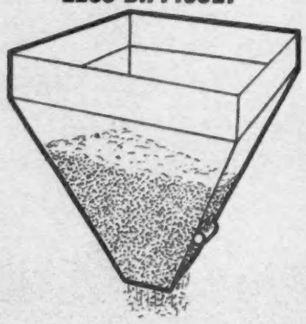
HYDRAULIC RAIL BENDER (REGISTERED PATTERN) FOR BENDING SIDEWAYS ACROSS THE FULL DEPTH OF RAIL. FOR ALL SIZES OF RAILS UP TO No. 11, BS SECTION 126 LBS/YD AND 150 LBS/YD CONDUCTOR RAIL.

Write for List No. Ryl157

YOUNGS (LIFTING APPLIANCES) LTD

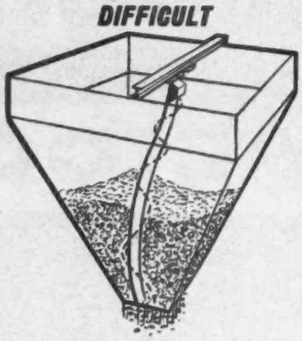
RYLAND STREET WORKS, BIRMINGHAM, 16. Tel.: EDGbaston 3508-9 Grams: OLDENS B'HAM

LESS-DIFFICULT



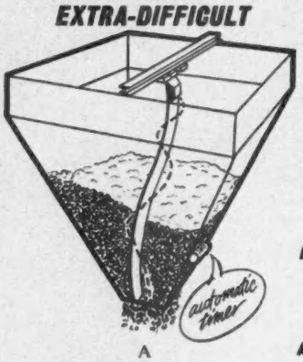
The installation of an external vibrator to a steel hopper.

DIFFICULT



The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.

trouble-free bunker discharge

The primitive, inefficient method commonly used for clearing material which sticks in a storage bunker is by applying a sledge hammer to the side of the hopper. This is a form of low frequency, uncontrolled vibration. When vibration is applied at the *correct* frequency, the *correct* amplitude and the *correct* point of application, almost any material can be satisfactorily discharged.

SINEX has the experience with a wide variety of materials and a wide range of hopper designs to recommend how vibration should be applied effectively to solve *your* particular problem.

The three examples illustrated show three different combinations which are typical of many applications, but even these, whilst using the same type of unit, can only be effective if the types of unit themselves are placed in the correct position and have the correct frequencies and amplitudes of vibration, to suit the characteristics of the material to be discharged.

It would pay you, therefore, to make use of our experience and to consult us on your particular problem.

Send for relevant details and information sheet.

These are some of the many materials which we have handled satisfactorily and ensured trouble-free bunker discharge: Pulverised and small coal, iron ore, coke, lime, flour, grain, grist, foundry sand, soda ash, cullet, sand, gravel, granite chips and all road stone materials.

Sinex

Bunker clearance Equipment

SINEX ENGINEERING COMPANY LIMITED

Centra Way, North Feltham Trading Estate, Feltham, Middlesex.

Telephone: Feltham 5081 (5 lines) Telegrams: Sinexvibro Feltham.

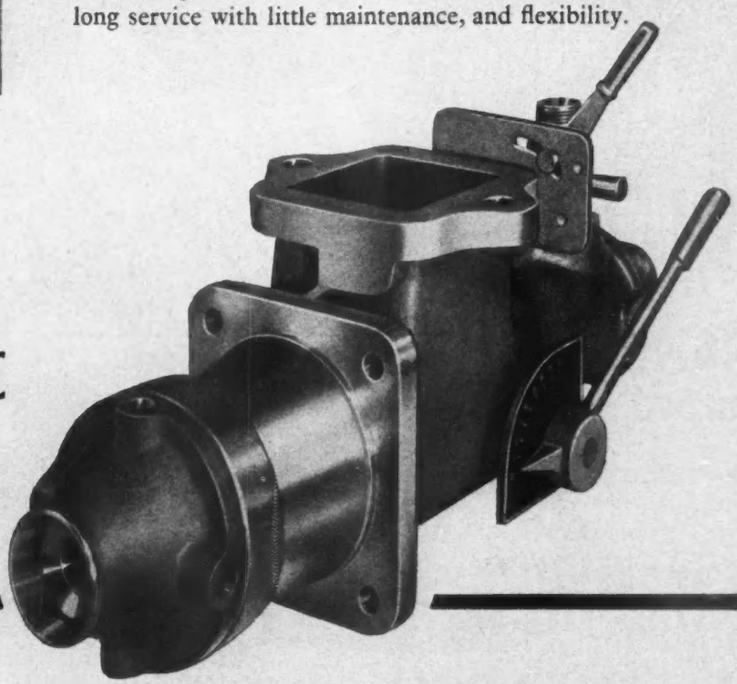
ASSOCIATED COMPANIES IN PARIS BRUSSELS AND ZURICH.

The Burner shown has a maximum output of 12 gallons per hour and requires atomising air at 20" (51 cm) w.g. to 30" (76 cm) w.g. with oil at not less than 5 lbs per sq. in. (0.35 kgs. per sq. cm.) or equivalent head.

Made to Measure

WALLSEND SELF-PROPORTIONING LOW AIR PRESSURE BURNER

- . . specially designed so that the fuel output and air/oil ratios are under complete control.
- . . provides fingertip, single lever control for accurate and efficient regulation.
- . . automatically ensures a correct mixture of air and oil over a wide range irrespective of the type of fuel in use.
- . . has a turn down range of approximately 5 : 1 which can be achieved with a stable flame, efficient combustion and a high CO_2 content.
- . . leads the way to automatic or remote control of single and multi-burner installations.
- . . incorporates the well known Wallsend features of robustness, long service with little maintenance, and flexibility.



For more efficient

OIL BURNING

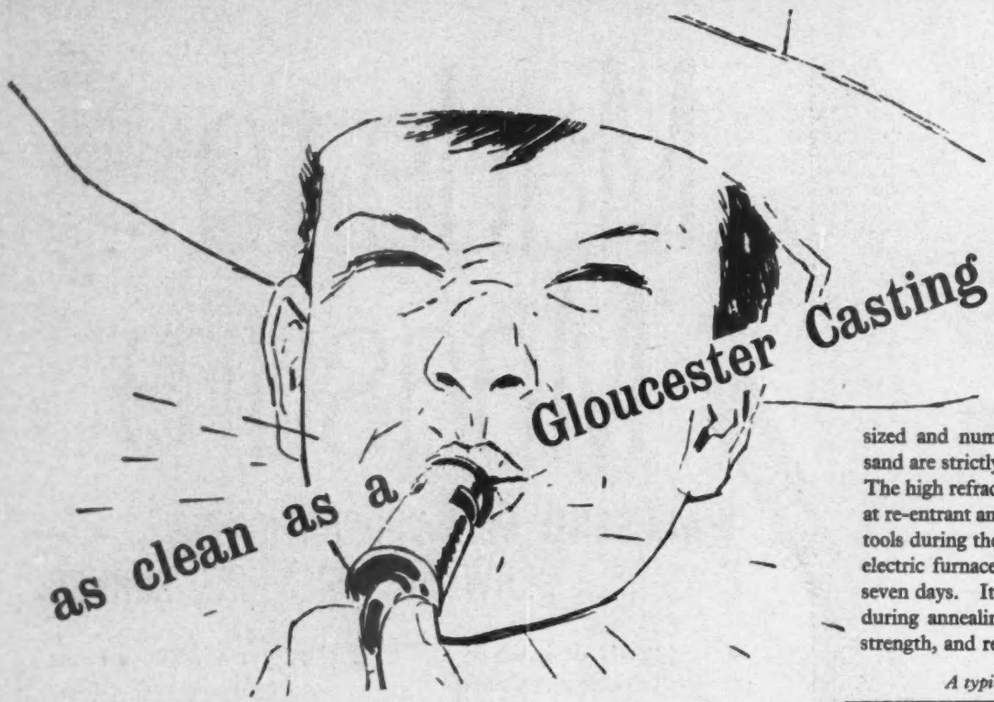
consult

THE WALLSEND SLIPWAY & ENGINEERING COMPANY LIMITED

WALLSEND-ON-TYNE

NEARLY 80 YEARS OF OIL BURNING EXPERIENCE

In association with HUBBARD COMBUSTION LIMITED, Kingston on Thames



"As clean as a Gloucester Casting" means that Gloucester malleable iron castings are of high definition, true to pattern, cleaner and smoother because of better sand practice and better fettling.

Mould and core sands and their bonding additives are under constant laboratory supervision, even the very sand grains are sized and numbered, and consistency and distribution of sand are strictly controlled by a continuous mechanical unit. The high refractory characteristics prevent sand "burn-on" at re-entrant angles, thus greatly increasing the life of cutting tools during the machining process. The new elevator-type electric furnace anneals in 48 hours!—instead of the usual seven days. It also allows greater control of the component during annealing, resulting in uniformity of metal, greater strength, and resistance to impact.

A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable		*Gloucester Lamellar Pearlitic Malleable*	
Elongation	18%	Elongation	5%
Yield Point	12 tons	Yield Point	24 tons
Tensile Strength	25 tons psi	Tensile Strength	35 tons psi

Bearing Bracket in Malleable Iron. Weight 3½ lb.

Brake shoe small vehicle Malleable Iron.

GLOUCESTER

Gloucester Foundry Ltd., Emlyn Works, Gloucester · Telephone: Gloucester 23041 · Telegrams: 'Pulleys' Gloucester · (A subsidiary of the Gloucester Railway Carriage & Wagon Co. Ltd.)

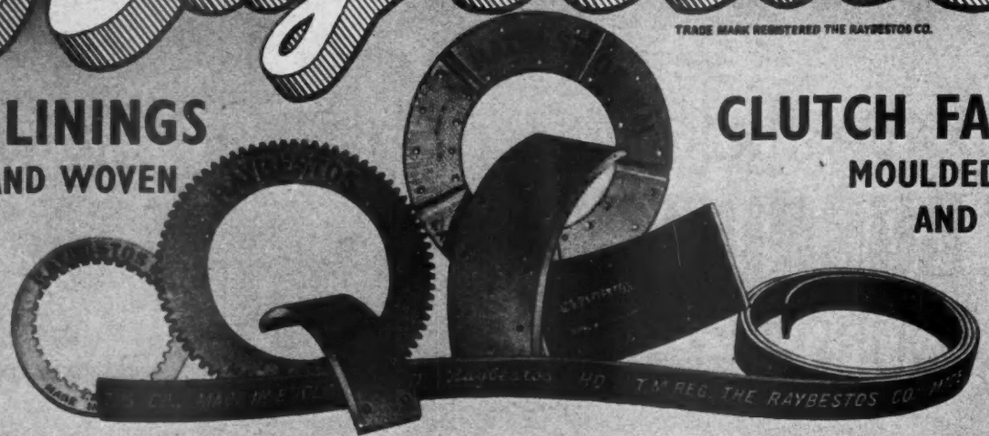
FOR INDUSTRIAL PLANT AND MACHINERY

Raybestos

TRADE MARK REGISTERED THE RAYBESTOS CO.

BRAKE LININGS
MOULDED AND WOVEN

CLUTCH FACINGS
MOULDED, WOVEN AND SINTERED



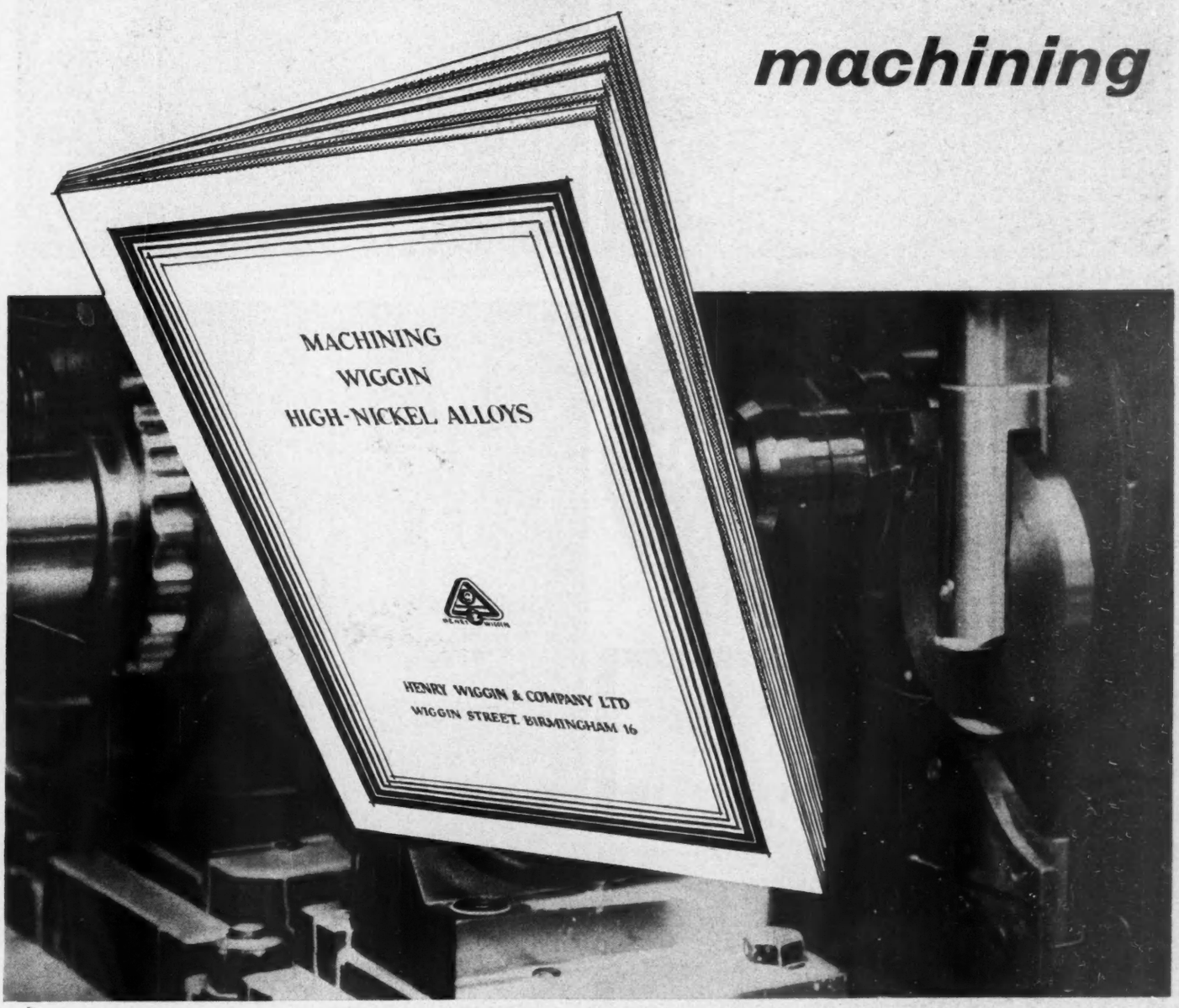
MADE IN ENGLAND

RAYBESTOS-BELACO LIMITED
EVERITE HOUSE SOUTHWARK STREET · LONDON, S.E.1

Telephones: WATerloo 7031-4, 3842-7

EXCLUSIVE DISTRIBUTORS OF RAYBESTOS PRODUCTS IN THE EASTERN HEMISPHERE

A new handbook on machining



Details of techniques successfully used for machining the Wiggin high-nickel alloys are given in this new handbook, available on request.

These recommendations cover:

nickel
- 'MONEL' nickel-copper alloy
- 'K' MONEL age-hardenable nickel-copper alloy
- 'NIMONIC' creep-resisting alloys
- 'NIMOCAST' heat-resisting casting alloys
- 'CORRONEL' corrosion-resisting alloys
- 'NILO' controlled-expansion alloys
- 'INCONEL' nickel-chromium-iron alloy

* *Trade Mark*

HENRY WIGGIN AND COMPANY LIMITED
WIGGIN STREET BIRMINGHAM 16

To Henry Wiggin & Co. Ltd., Wiggin Street, Birmingham 16

Please send me a copy of your handbook 'Machining Wiggin High-Nickel Alloys'.

NAME_____

APPOINTMENT OR DEPARTMENT_____

COMPANY AND ADDRESS_____

_____ EE/M32 5

TGA M83A

Coal picking belts.

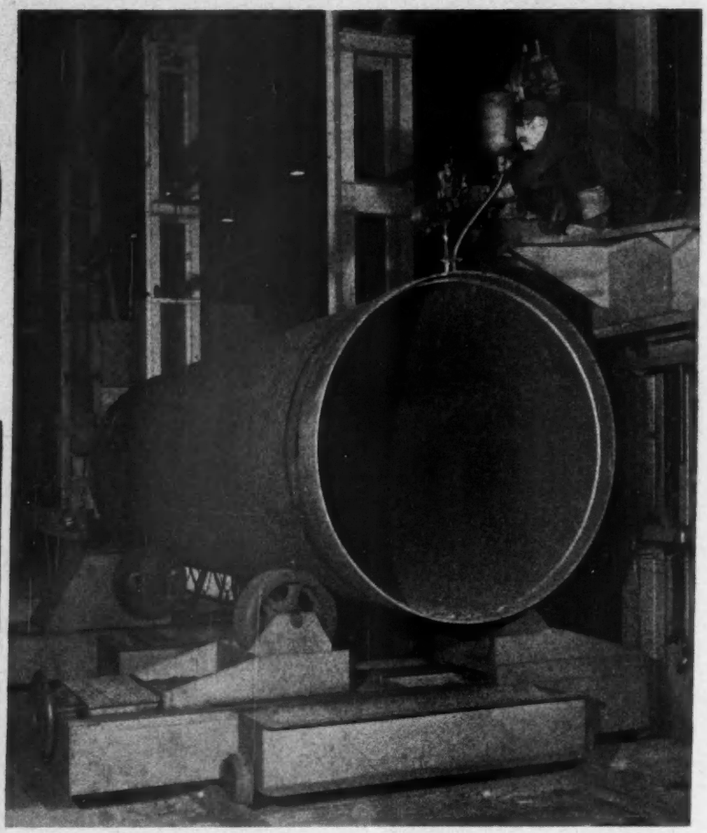
High Pressure Gasholders.

FOR ALL ROUND SATISFACTION

combining sound design, materials and workmanship

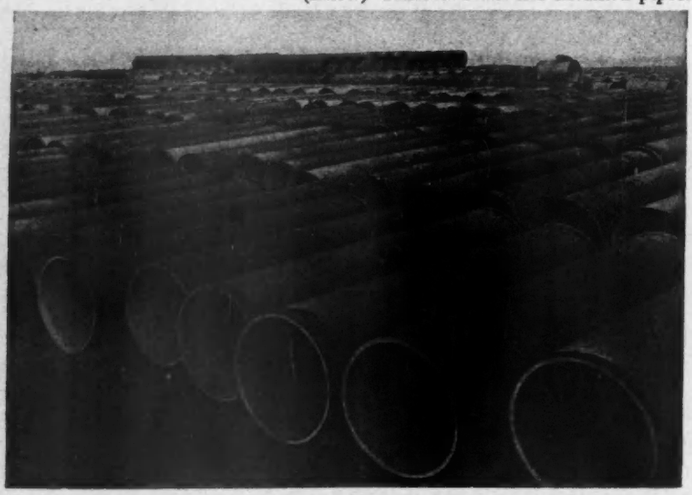
CLAYTON

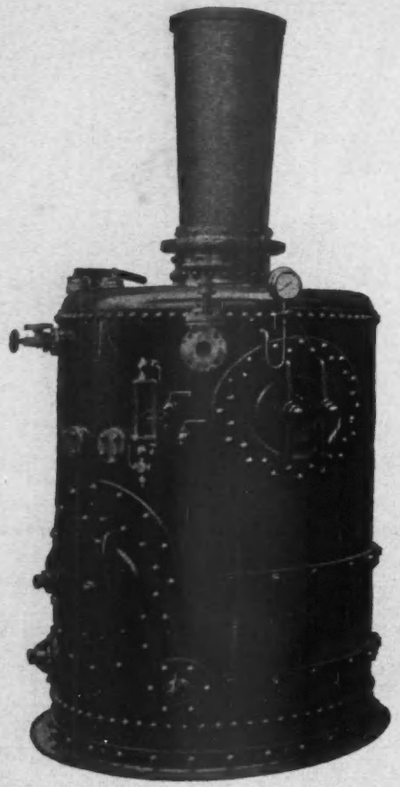
CLAYTON SON & CO LTD.
ENGINEERS
HUNSLET LEEDS 10



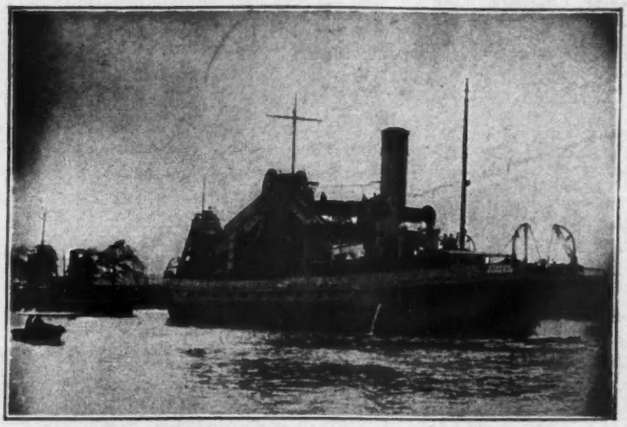
(*Top*) Precision welded steel pipes.

(*Below*) Concrete lined and sheathed pipes.





Hopwood vertical boiler.



OIL-BURNING TWIN-SCREW HOPPER DREDGER "OTAKOU"
constructed for the
OTAGO HARBOUR BOARD, DUNEDIN, NEW ZEALAND
Dimensions: 258 ft. × 20 ft. Hopper capacity 2,000 tons
Speed loaded: 9½ knots Dredging capacity per hour: 1,000 tons

DREDGING PLANT

TO THE LARGEST DIMENSIONS AND CAPABILITIES

PATENT CUTTER SUCTION DREDGERS, PATENT DIPPER DREDGERS, BUCKET HOPPER DREDGERS, SUCTION HOPPER DREDGERS, HOPPER BARGES, PIPE LINES FLOATING CRANES, etc.

NEW BUCKETS, LINKS, PINS, GEARING, etc., supplied for existing Dredgers

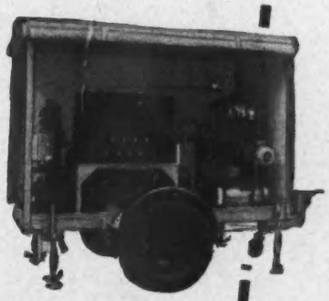
FLEMING & FERGUSON, Ltd.,
SHIPBUILDERS & ENGINEERS, PAISLEY, SCOTLAND
Phone: Paisley 4121 *Teleg. Address: "Phemix, Paisley"*
London Agents: Messrs. Nye & Marks Ltd., Capel House, 62 New Broad Street, London, E.C.2
Telephone: LONDON WALL 4846

DE LAVAL CENTRIFUGAL

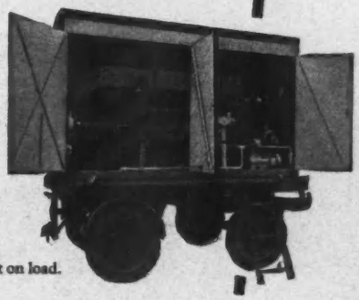
HIGH VACUUM SEPARATORS for INSULATING OIL TREATMENT

A wide range of Stationary, Portable and Roadworthy Portable Units with capacities from 10—1200 g.p.h.

120 g.p.h.



800 g.p.h.



1200 g.p.h.

Specially designed high-efficiency equipments that ensure:—

Maximum di-electric strengths, well above B.S.S. requirements for new oils, which are retained for longer periods.

Maximum extraction of free and dissolved moisture, air and solids, including colloidal carbon.

No back pressures or fall-off in throughput capacity.

Excessive quantities of water, sludge or solids which may be formed under abnormal conditions can be efficiently separated.

Minimum heating of oil under high vacuum, low running costs—no filter aids— simple and reliable operation.

These De Laval equipments are now widely employed for:—

1 De-hydration and de-aeration of new oil when filling new transformers at site.
2 Drying out cores and windings of:—
(a) new transformers at site before they are put on load. (b) existing transformers whilst on load.
3 Improving the breakdown strength of oil in transformers on load.
4 Improving insulation resistivity of transformers.
5 Treatment of used transformer and switch oils in oil storage tanks.

OIL EQUIPMENT DIVISION
ALFA-LAVAL COMPANY LTD · GREAT WEST ROAD · BRENTFORD · MIDDLESEX
Tel: ISLeworth 1221

Smal's DL.401

LOCOMOTIVES

Designers and Builders of Steam, Diesel and Diesel-electric and Battery Locomotives for all purposes. Flame Proof Diesel and Battery Locos for underground working.

HUDSWELL, CLARKE & COMPANY LIMITED
Railway Foundry, Leeds
LONDON OFFICE:
14 Howick Place
Victoria Street, S.W.1
TELEPHONE: Victoria 6786

DYSON TRAILERS

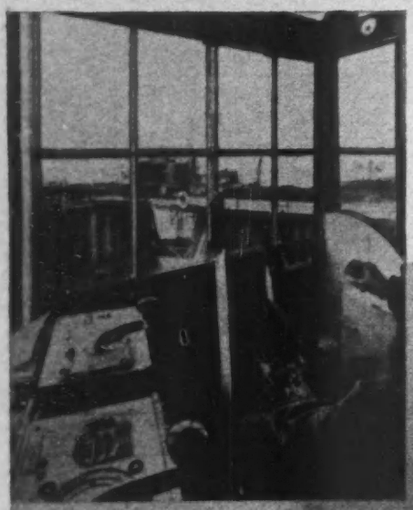
THE BEST OF HAUL INVESTMENTS

R. A. DYSON & CO., LTD.
LIVERPOOL

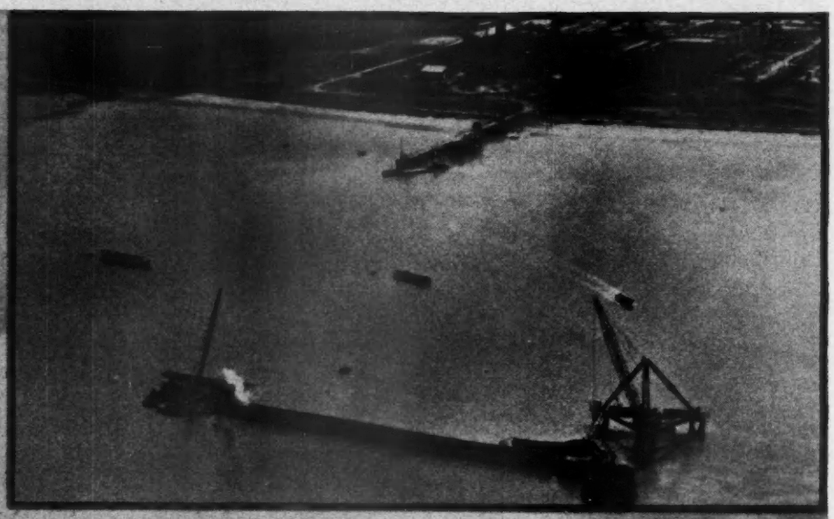
HENDERSON

supply a special crane for BRADWELL

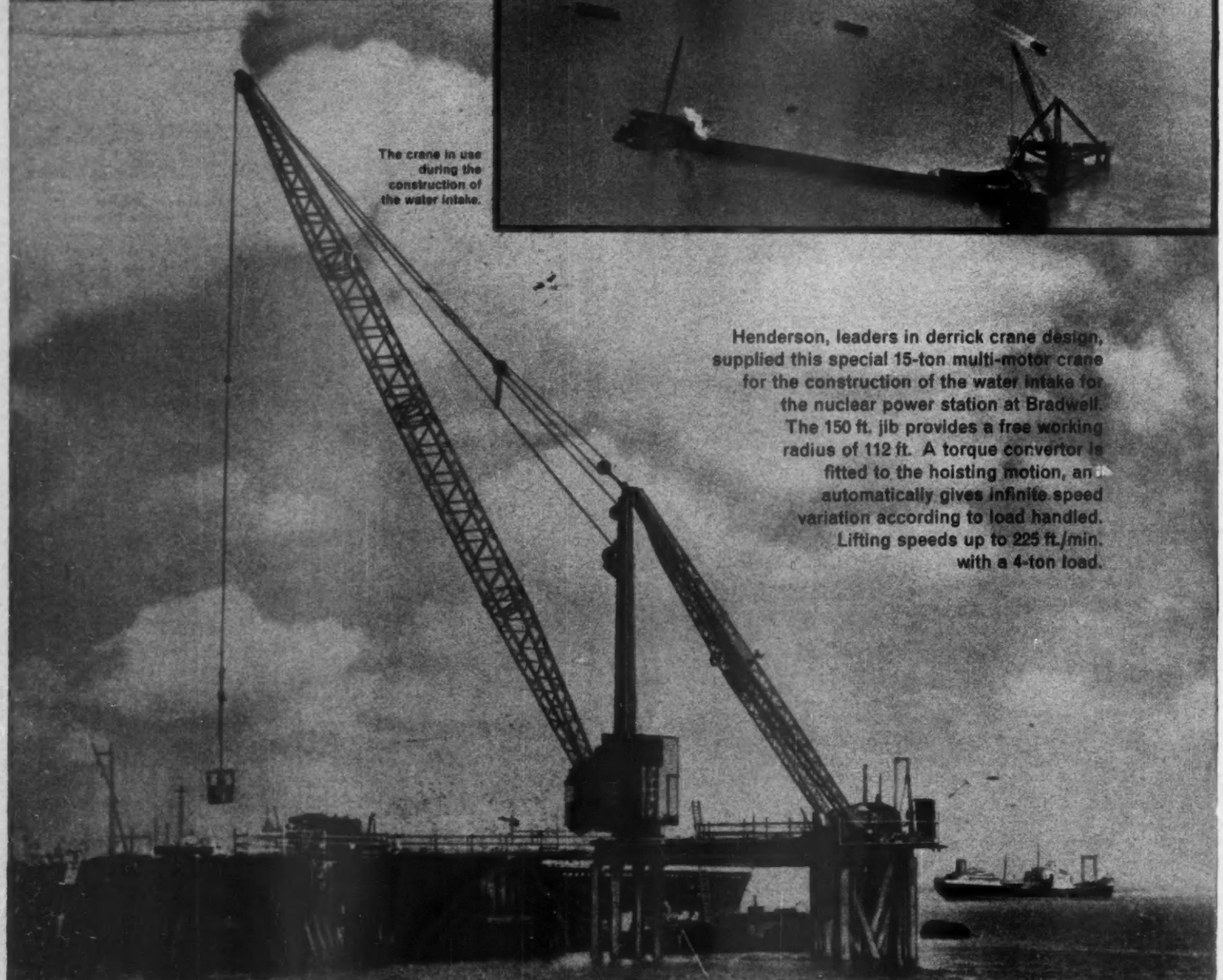
With acknowledgements to Sir Robert McAlpine & Partners



The operator's cabin, showing the wide field of vision and easily accessible controls.



The crane in use during the construction of the water intake.



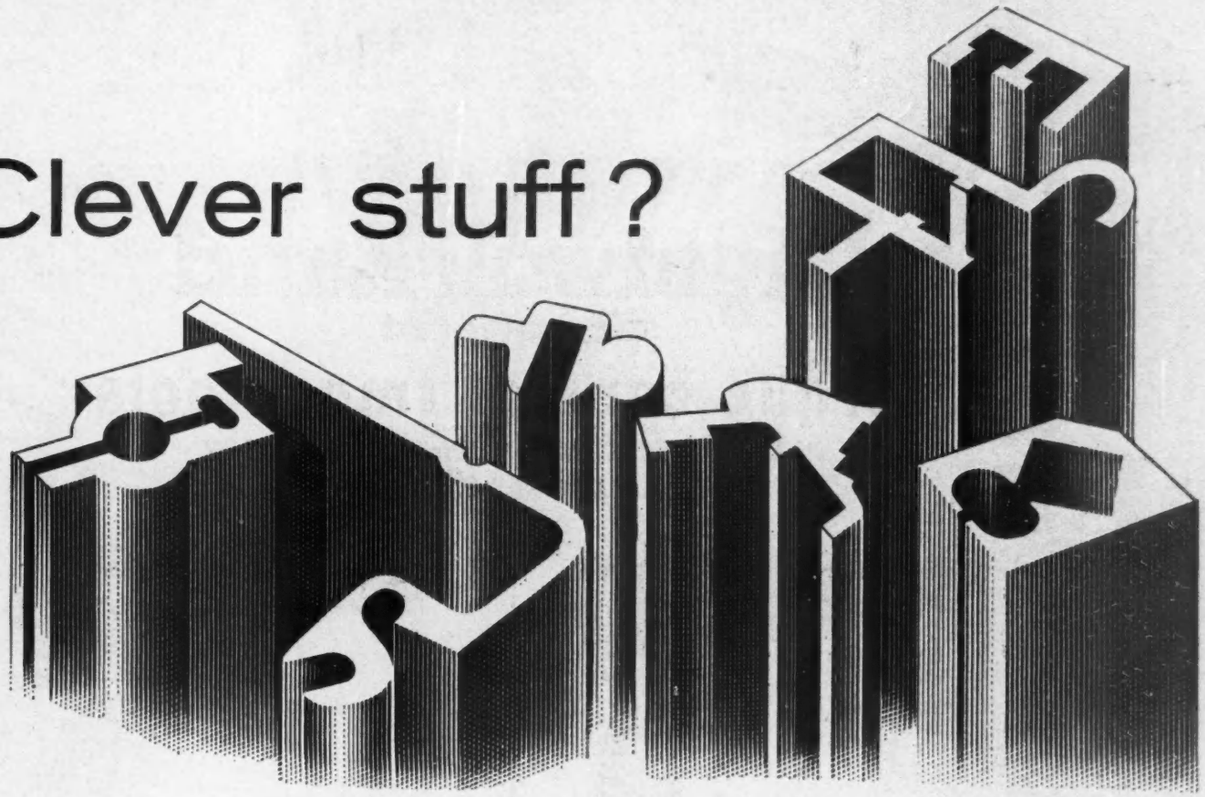
Henderson, leaders in derrick crane design, supplied this special 15-ton multi-motor crane for the construction of the water intake for the nuclear power station at Bradwell. The 150 ft. jib provides a free working radius of 112 ft. A torque convertor is fitted to the hoisting motion, and automatically gives infinite speed variation according to load handled. Lifting speeds up to 225 ft./min. with a 4-ton load.

JOHN M HENDERSON & COMPANY LIMITED

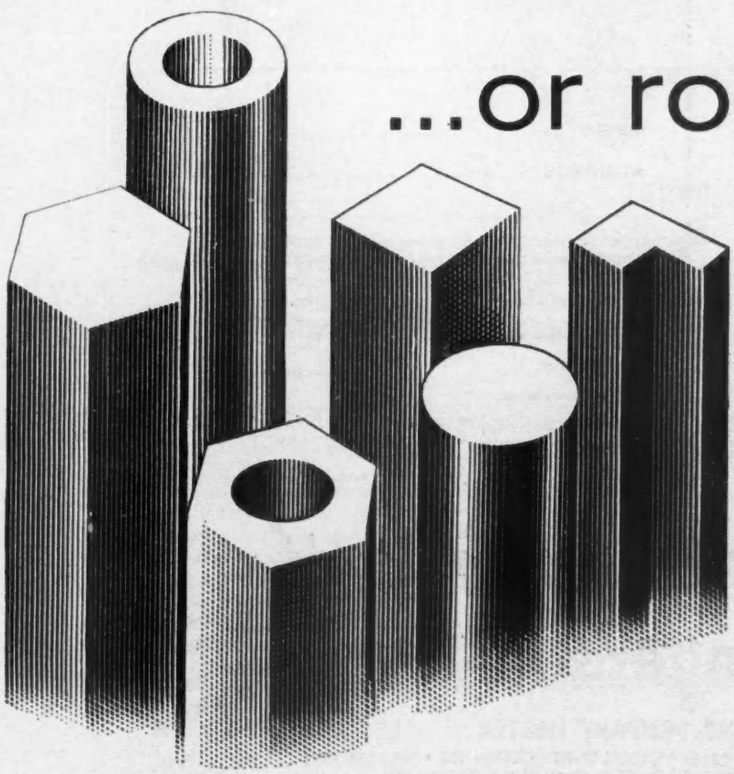
KINGS WORKS ABERDEEN Tel: CENtral 24262 (3 lines) Grams: Cranes Aberdeen

P.4590

Clever stuff?



...or routine job?



BOTH at Vickers.
All types of extrusions
in brass. Fine limits,
good quality, quick delivery.

Write or phone
for information to:

Non-Ferrous Metals Department
(Division 6),
Vickers-Armstrongs (Engineers) Limited,
Elswick Works,
Newcastle upon Tyne.
Telephone: 33101

Brass extrusions by VICKERS

Vickers-Armstrongs (Engineers) Limited

Ingersoll-Rand

air powered

Torque control Impactools

run nuts accurately and automatically to pre-set torque

SIZE 5020T

SIZE 5081T

SIZE 5040T

BRITISH MADE

NAME_____

ADDRESS_____

Ingersoll-Rand hand-held power tools are made and designed specifically for the following industries. Please tick the industry with which you are concerned. Descriptive literature will be mailed to you by return.

- ☐ Oil & Petroleum
- ☐ Iron & Steel
- ☐ Fabricated Metals
- ☐ Automobile
- ☐ Aircraft
- ☐ Railway
- ☐ Ship & Boat Building
- ☐ Machinery (Mechanical)
- ☐ Machinery (Electrical)
- ☐ Mining
- ☐ Public Utilities (Electricity, Gas, Water, Telephone, etc.)

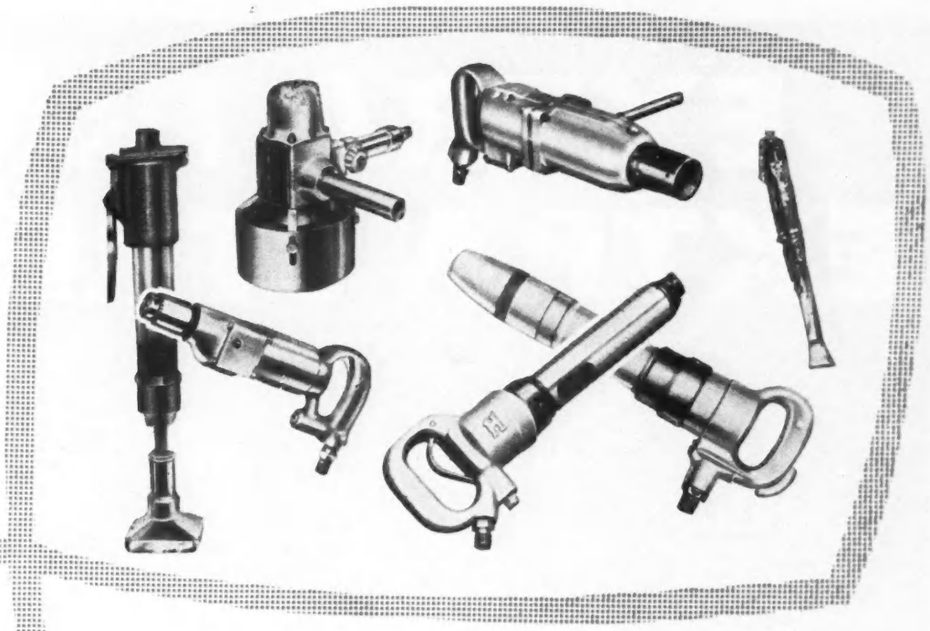
Power in hand with

Ingersoll-Rand

INGERSOLL-RAND COMPANY LIMITED

165 QUEEN VICTORIA STREET LONDON EC4 • TEL: CEN 5681
Scottish Office: 20 Renfrew Street Glasgow C2
Tel: Douglas 1233 • Grams: Ingersoll Glasgow

P.5805



Does air power it?

Then Holman make it

Now what's the best tool for *this* job, you ask. Pneumatic? Yes. Holman? Undoubtedly. Ah, but do Holman *make* it?

They do. Holman make pneumatic equipment for every project. There's hardly a job-need anywhere they don't know about — and deal with. Mining, shipping, construction — wherever tough, fast-working tools can get down to the job and cut down the costs.

Take your choice — from the widest range of air compressors and pneumatic tools in the Commonwealth. The most reliable in the world.

Write now for catalogue 15/G.P.1

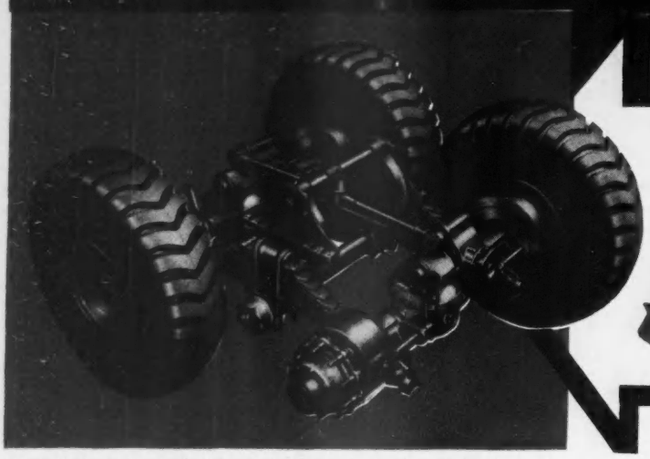
Air... compressed air... **power...** **Holman**

Holman Bros. Ltd., Camborne, England; Camborne 2275 and 44 Brook Street, London W.1; Hyde Park 9444.
Also in Birmingham · Cardiff · Glasgow · Peterborough · Sheffield. Australia · Canada · East Africa · France
India · South Africa · Spain · U.S.A. · West Africa. With Agents and Representatives throughout the world.

HM16

C

EXTRA POWER EXTRA STRENGTH



and EXTRA ARTICULATION

The double-drive fully-articulated rear bogie is a unique feature of the A.E.C. "Dumptruk".

The tough, powerful, economical 10 cu. yd. A.E.C. "Dumptruk" does far more work in less time and gives a lower cost per yard moved than any other comparable dump truck on the market today. Powered by the field-proved 150 b.h.p. diesel engine with a high torque output driving through a specially developed constant mesh gearbox, the A.E.C. "Dumptruk" has the stamina to meet the most gruelling conditions. With double acting rams it reaches a 70° tip in 10 secs, with power return.

AEC

10 CUBIC YARD

DUMPTRUK

Designed, powered and built by

A.E.C. LIMITED · SOUTHALL · MIDDLESEX

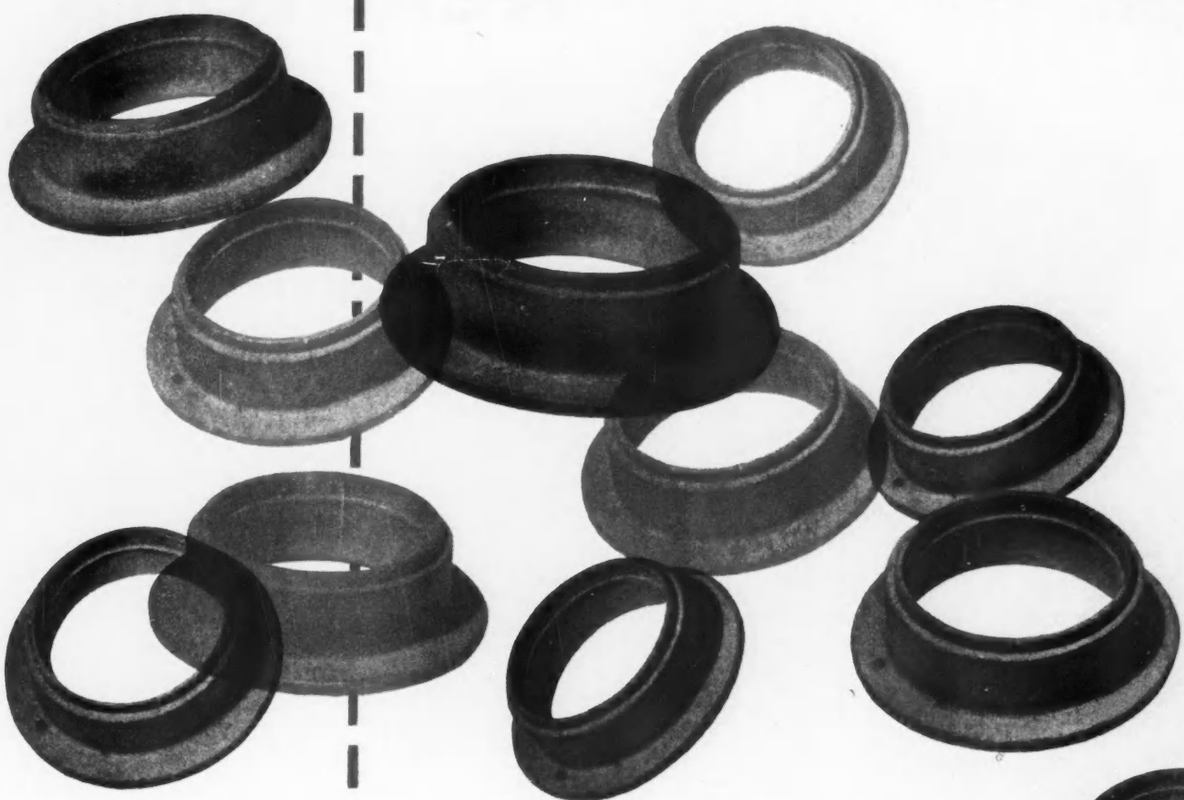
Sole distributors in U.K. **SCOTTISH LAND DEVELOPMENT CORPORATION**
72 Dykehead Street, Queenslie, Glasgow, E.2 & 32 St. James's Street, London, S.W.1.
Sales & Service Glasgow, Newcastle-upon-Tyne, Nottingham, London.

SL DC

CV/576

cast in steel

to increase output



with 40% less machining time & 12% less material used

Modern steel foundries have many techniques for manufacturing economically to a high degree of accuracy.

This Bung Bush for Brewery use was shell moulded, and showed 12% reduction in weight of material used and 40% reduction in machining time when compared with the previous production method. Output was increased considerably at less cost.

Why not take advantage of steel foundry know-how—call in a steel foundry engineer at the design stage and solve your problems in the most economical way.

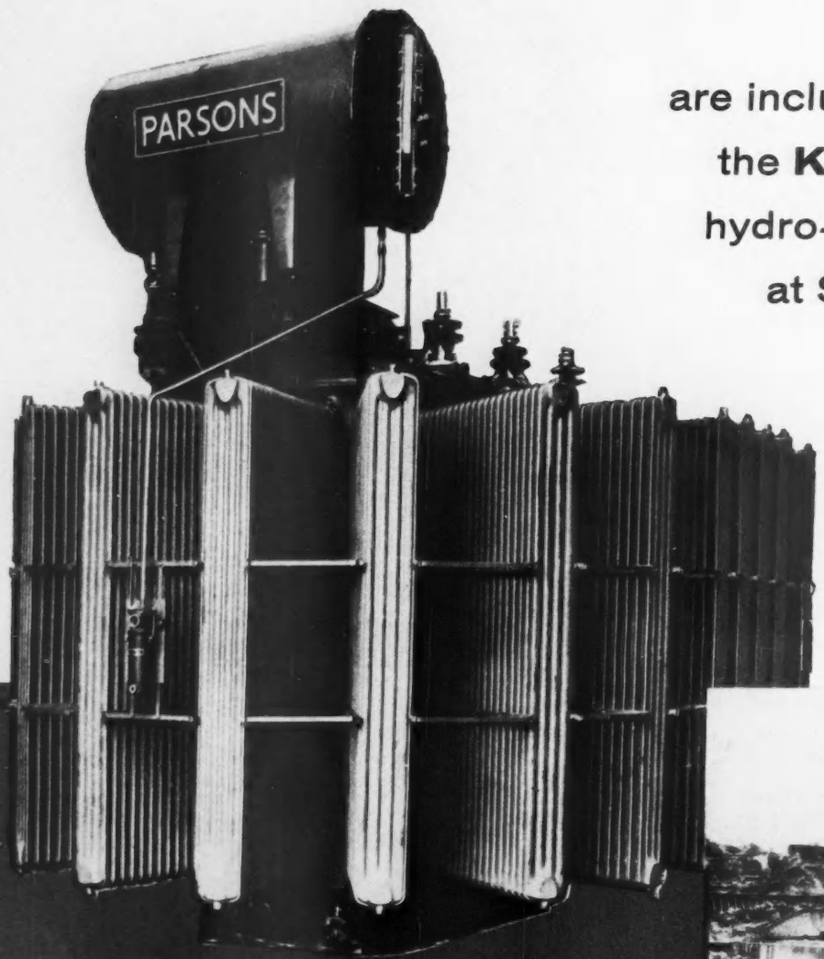
THE BRITISH STEEL FOUNDERS ASSOCIATION
Broomgoove Lodge, Broomgrove Road, Sheffield.

BSFA
STEEL CASTINGS

POWER

9 PARSONS 20 MVA 11kV REACTORS

are included in the **KARIBA** hydro-electric scheme at Salisbury, Kitwe, Norton, Sherwood and Bulawayo substations.

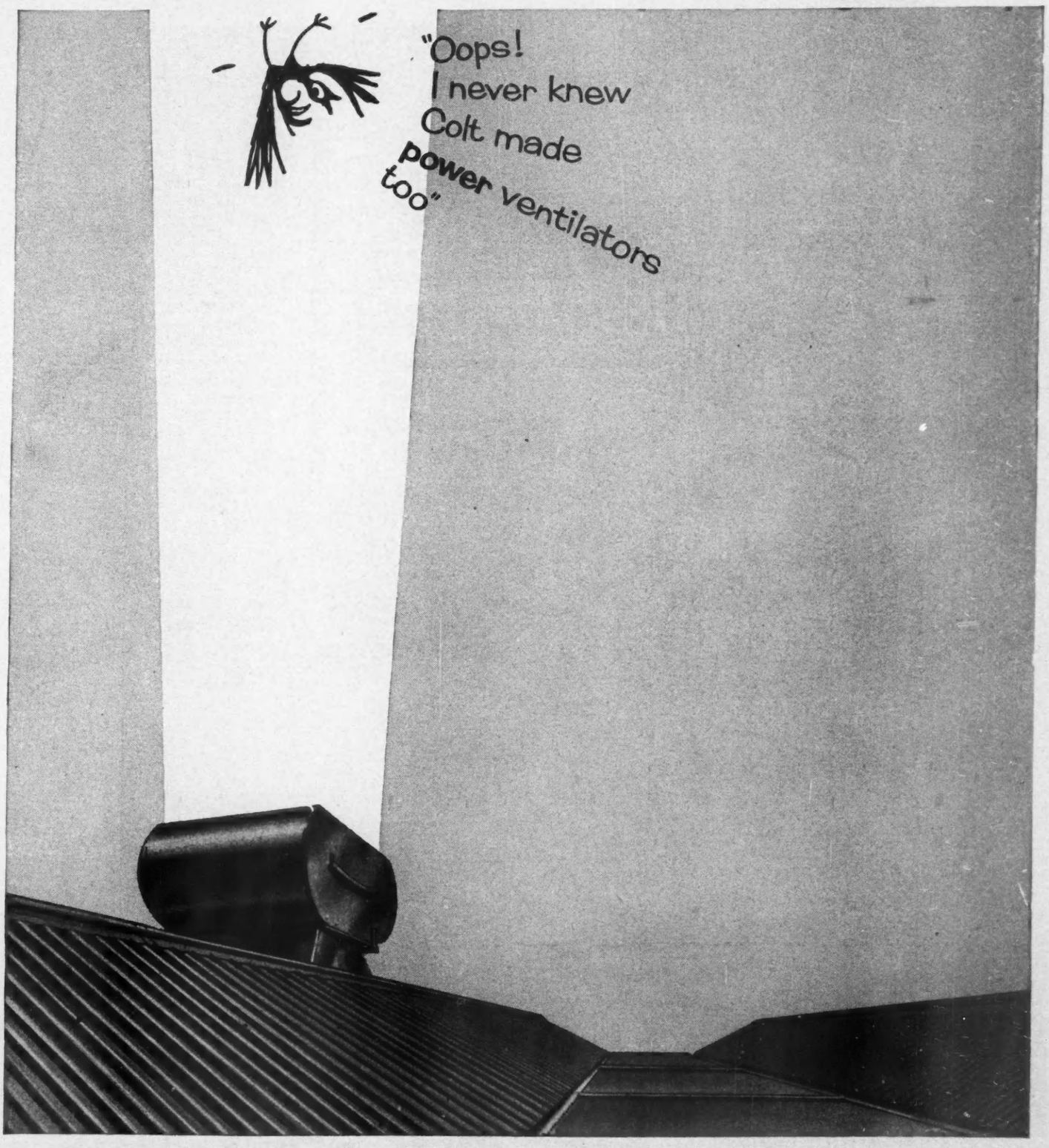


For shunt compensating . . . Connected to 11 kV tertiary windings of transmission transformers and operating on 3 phase, 50 cycle system. O/N type cooling.

PARSONS

TRANSFORMERS

C. A. PARSONS & CO. LTD · HEATON WORKS · NEWCASTLE UPON TYNE



They do! Colt have a ventilator, natural or powered, to meet every kind of problem—including a range of high powered ventilators such as the Upward Discharge unit shown here. Let the Colt Ventilation Service advise you. Powered or natural, or a combination of both—the Colt engineer will tell you which system is best and most economical for you. Send for a manual to Dept. 37

COLT

The power behind natural ventilation and naturally behind powered ventilation too!

COLT VENTILATION LIMITED · SURBITON · SURREY · TEL: ELMBRIDGE 0161

ROBUST IN CONSTRUCTION
WIRE-BRAID REINFORCED
WITHSTANDING
200 LBS. P.S.I.

US RUBBER MATCHLESS

HIGH
PRESSURE
STEAM HOSE

PLUS POINTS

- Natural rubber, heavy gauge, seamless tube.
- Manufactured in 60 ft. lengths.
- High tensile wire-braid reinforcement with special spiral asbestos cord which incorporates a static conducting wire.
- Light-weight yet of great strength.
- Neoprene cover, compounded to withstand extreme heat and abrasion.

Specially designed for high-pressure operations, this wire-braid hose handles 200 lbs. p.s.i. The spiral asbestos cord with static conducting wire is incorporated for additional safety. This is one of the many types of hose for general industrial use, backed by the world-wide experience of U.S. Rubber, manufactured at Edinburgh in Europe's most modern plant. Robust, reliable and efficient, each in its category is unequalled value for all-round service and economical operation.

Detailed and illustrated catalogue on U.S. Rubber Hose is obtainable on request.

US RUBBER **U. S. Rubber**

Home: *The North British Rubber Company Limited.* | ABBey 5611
Export: *U.S. Rubber International (Great Britain) Ltd.*

62/64 HORSEFERRY ROAD, LONDON, S.W.1

The world's largest manufacturer of industrial Rubber Products.
Famous for: Steam, Oil, Air & Water Hose · Conveyor Belting · PowerGrip Timing Belts · Dock Fenders · Expansion Joints

100 YEARS 1860-1960

Radicon—the quick answer on speed reduction

The quickest way to solve your speed reduction problems is to call in David Brown. Their stock range of RADICON speed reducers covers all reasonable requirements and offers for your choice, 330 combinations of type, size and ratio in standard units from 2¼ to 14—available for despatch within 24 hours.

Behind every 'Radicon' there are 100 years of sound technical and production experience. In front of every 'Radicon' there is a long, long life of hard, hard work.

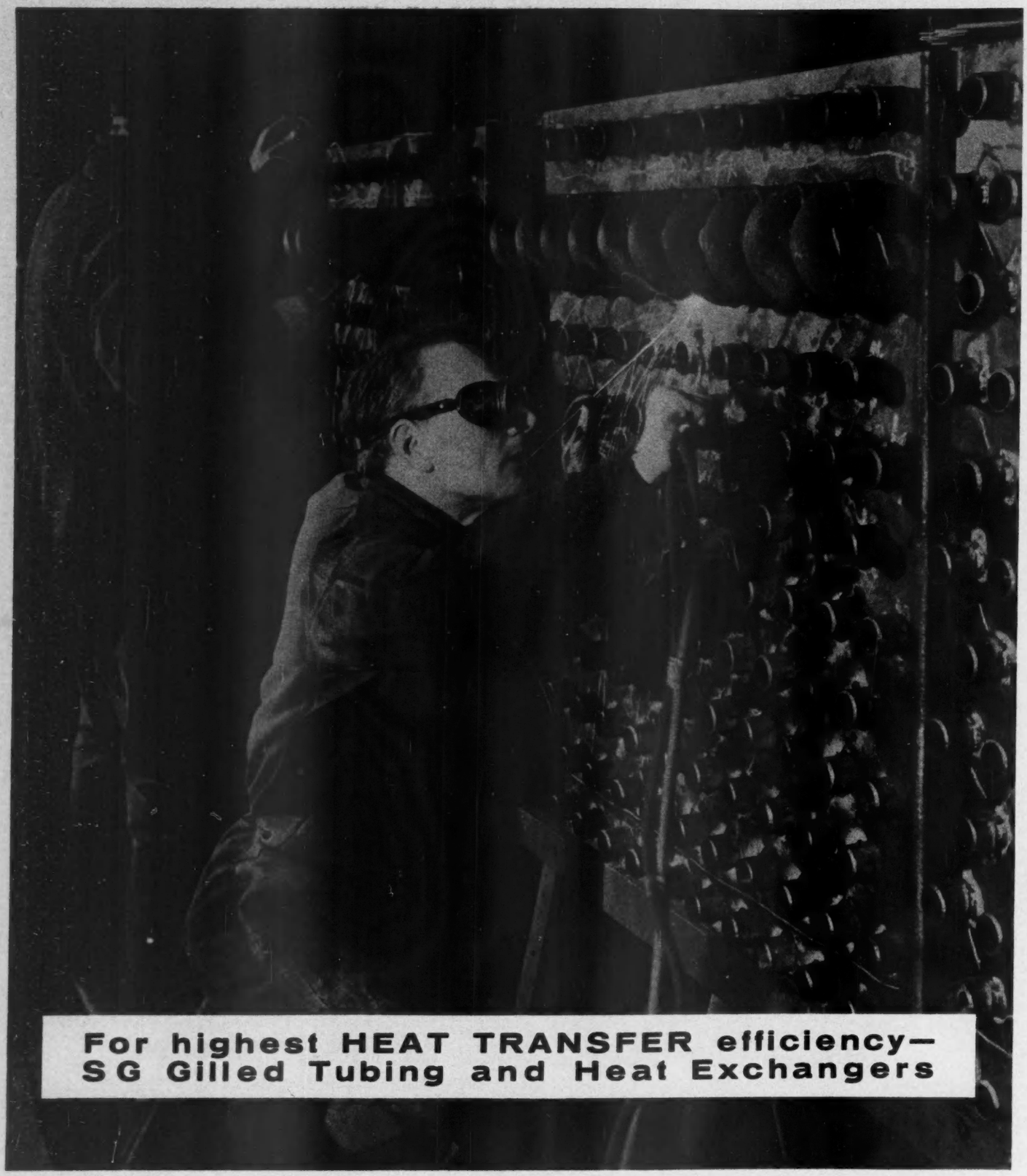
If your problem is urgent, write for catalogue F.487.20. If it's desperate, please telephone.

DAVID BROWN

An alliance of engineering specialists in gearing, machine tools, castings, automobiles, and agricultural tractors and machinery.

DAVID BROWN CORPORATION (SALES) LIMITED

RADICON DIVISION, (SIZES 2¼ TO 28) • PARK WORKS • HUDDERSFIELD • TELEPHONE: 3500



Heating, cooling, refrigeration—whatever the application, the medium or the conditions, our expert knowledge of heat exchanger design can save you time and money. Besides supplying S.G. gilled tubing in most metals, we make complete heater batteries, coolers, condensers, evaporators, etc., for every branch of industry. We specialise in " specials ", either to your drawings or designed throughout by us to give the figures you require.

Full facilities available for inspection by Lloyds, Boiler Insurance Companies and Consulting Engineers, to British and American Codes of Inspection.

SG

SPIRO-GILLS LTD
London Road, Pulborough,
Sussex *Pulborough 2401/5*

TA2388

OLYMPIA, LONDON

June 25—July 8 *(Sundays excepted)*

9.30 am—6 pm

Make sure you visit the greatest engineering event of the year — The International Machine Tool Exhibition . . . No-one concerned with quantity production — whether in technical, administrative or operative capacity — can afford to miss this vast and truly comprehensive show at Olympia, London. It summarizes the best of contemporary production techniques; it shows the shape of things to come!

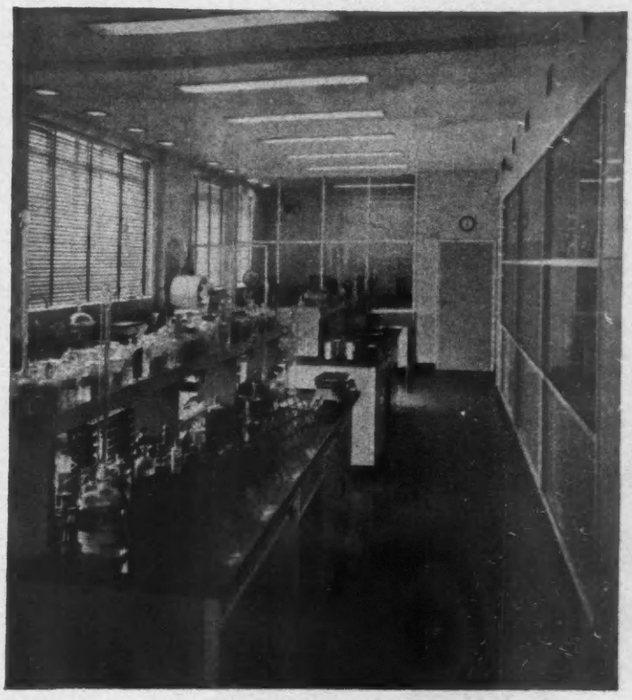
Machine Tools
Engineers' Small Tools
Gauges and Measuring Equipment
Testing Equipment
Electronic Control Gear
Presses and Power Hammers
Woodworking Machinery
Heat Treatment Plant

Here's your opportunity to see them all under a single roof — to see many of them powered and in operation — to discuss their application to your own production problems with the world's best-informed production experts.

International Machine Tool Exhibition 1960

Organized by The Machine Tool Trades Association, Brettenham House, Lancaster Place, London, W.C.2.

The Laboratory



CONSIDER it yours—it is equipped and staffed for dealing with ***your*** *specific problems concerning metal cleaning and stripping. From this centre of technical research "S.A.C." maintain a nation-wide service of information and specification on treatments that save both time and cost.*

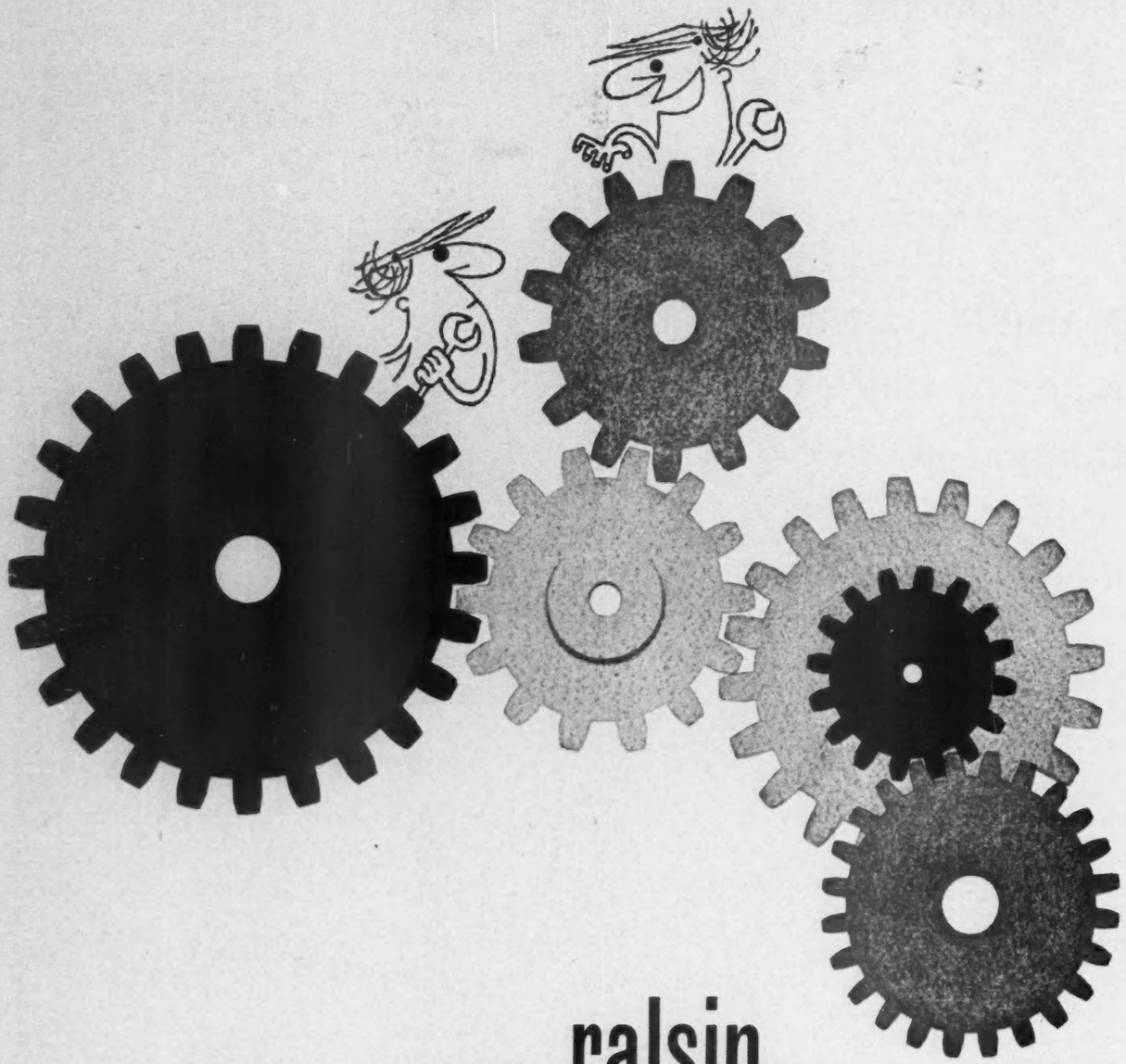
PRODUCTION PROVED PRODUCTS

SUNBEAM ANTI-CORROSIVES LTD.

CENTRAL WORKS · CENTRAL AVENUE
WEST MOLESEY · SURREY
Telephone: Molesey 4484 (5 lines)
Telegrams: Sunanticor, East Molesey

Manufacturers of
STRIPALENE · FERROCLENE · ALOCLENE · FERROMEDE · BRAZOCLENE
(Regd. Trade Marks)
APPROVED BY ADMIRALTY, WAR OFFICE AND AIR MINISTRY

now this 'ere gear 'ere



is made from **ralsin** Nylon 11 . . . and that makes it special. If you'd made the same thing in, let's say steel for instance, it would have needed lubricating for a start all the time—which is just what you wouldn't have to do if you'd made it of RALSIN in the first place. And last; they really do last . . . made of RALSIN. Silent meshing too . . . smeshing!

RALSIN in light engineering provides mouldings and extrusions of great mechanical strength which are dimensionally stable, shock and abrasion resistant and light in weight.

For prototype work, RALSIN can be machined. The material has a high degree of dimensional stability and piece parts produced from RALSIN are capable of being operated continuously at temperatures up to 100°C and down to as low as —64°C.

RALSIN (density 1.04) is the lightest polyamide available commercially. There are many ways in which RALSIN can improve your present products; it can also be instrumental in achieving success—particularly with intricate projects. Whiffens Publication No. R/2/16 will give you all the details you will need about its application and characteristics. Their Technical Service Department will be happy to talk over any particular details of application with you.

WHIFFENS chemicals for industry

A member of the Fisons Group of Companies

Sole agents for RALSIN in the United Kingdom, Commonwealth of Australia and Dominions of New Zealand and Canada.

WHIFFEN AND SONS LIMITED
Willows Works · Derby Road · Loughborough · Leicestershire · Telephone: Loughborough 3141

For problems involving the safe transfer of liquids and gases, SMITHS offer Petro-flex Tubing, a 'proper channel' that is . . . resistant to the action of water, petrol, gases, vegetable and mineral oils and many industrial solvents within the temperature range —40° to +80°C, . . . strong, light, durable and resistant to fracture by vibration.

TYPES

N.E. Plain extrusion of synthetic rubber with external metal braid; 50-ft lengths; bores up to $\frac{3}{8}$".

N.E.O. Similar to N.E. but with additional cotton braid between the o/d and external metal braid.

N.A. Double-armoured, the internal armouring being partially embedded in the rubber, thus giving a smooth bore.

Suction and Delivery Hose. Ideally suited to heavy industrial applications. Lengths up to 15 ft; bores up to 3".

SMITHS Petro-flex Tubing and Suction and Delivery Hose are available in Grades, Diameters and Lengths, and with a choice of End Fittings, to suit most industrial applications.

Send us details of your flexible tubing problems

SMITHS

INDUSTRIAL INSTRUMENT DIVISION

Chronos Works, North Circular Road, London, N.W.2 Telephone: GLAdstone 1136

AP/398

Stand No. H.10 (Ground floor) at the Electrical Engineers Exhibition.

NO WAITING with an I.C.I. Degreasing Plant.

When you use an I.C.I. Dregreasing Plant for cleaning metal there's no waiting—the job's done quickly and efficiently. I.C.I. manufactures a wide range of plants, including some that are totally enclosed and fully automatic—and work at the press of a button!

For literature and information write to:

IMPERIAL CHEMICAL INDUSTRIES LTD., LONDON, S.W.1

DP 264

LISTER TECHNICAL ANNOUNCEMENT

LISTER air-cooled diesel engines 1½–72 h.p.

CONTINUOUS RATINGS

The following table of H.P. ratings and speeds will assist you in selecting a suitable Lister Air-Cooled Engine for your job :—

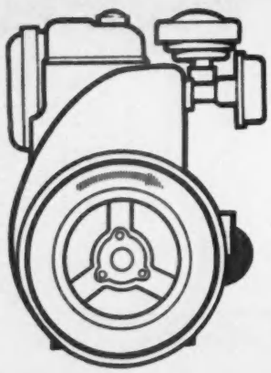
ENGINE TYPE	HORSEPOWERS				
Speed	750 r.p.m.	1000 r.p.m.	1500 r.p.m.	1800 r.p.m.	2000 r.p.m.
LD1	1·5	2·0	3·0	3·5	
LD2	3·0	4·0	6·0	7·0	
SL1		2·4	3·6	4·25	4·75
SL2		4·8	7·2	8·5	9·5
SL3		7·2	10·8	12·75	
SL4		9·6	14·4	17·0	
HA2		12·0	19·0	22·0	
HA3		18·0	28·5	33·0	
HA6			57·0	66·0	72·0
HB2					24·0
HB3					36·0
Speed	650 r.p.m.	850 r.p.m.			
VA	5·75	7·5			

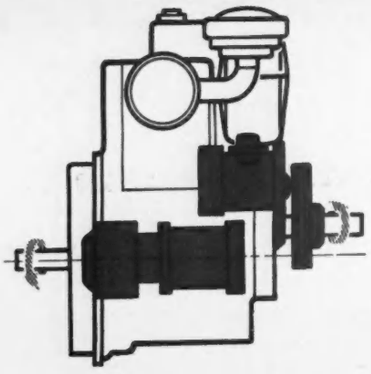
These engines are available with a wide range of accessories—see overleaf for details of the LD & SL twin and three cylinder engines. Similar data furnished on request for other Lister Air-Cooled engines.

Tested and found true to the Lister tradition !

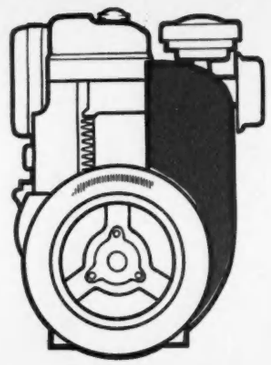
AIR-COOLED ENGINES TYPES 'LD' & 'SL'

NOTE: 'LD' & 'SL' engines are identical in outward appearance and dimensions.

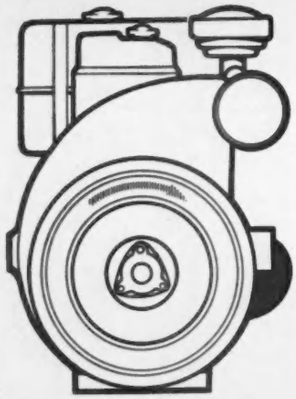


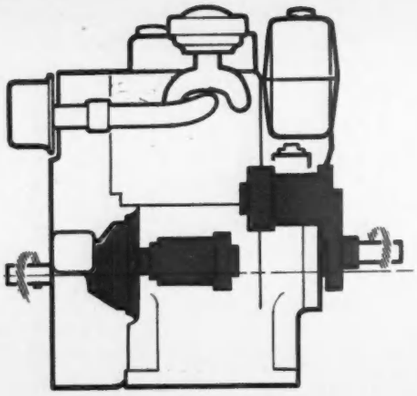


GENERAL ARRANGEMENT—LD1 & SL1
(Also showing electric starting)

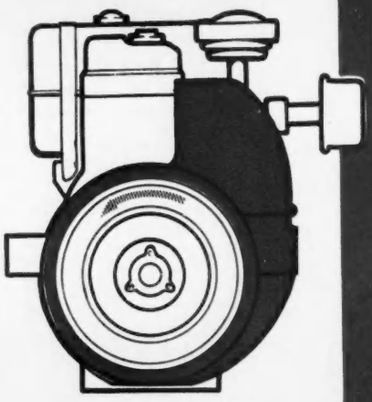


REVERSE ROTATION

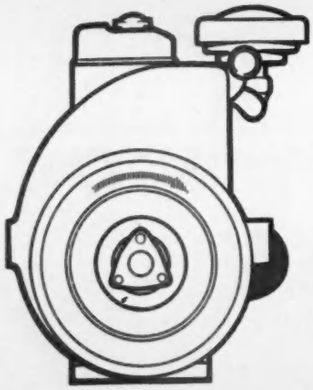


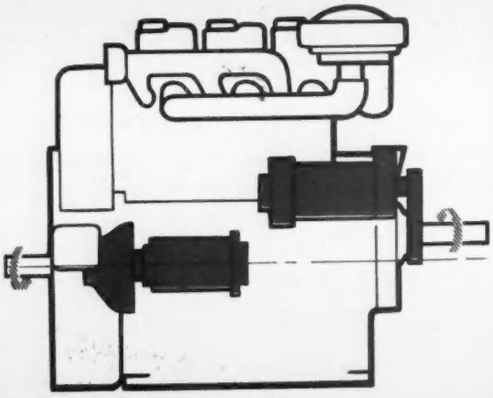


GENERAL ARRANGEMENT—LD2 & SL2
(Also showing electric starting)

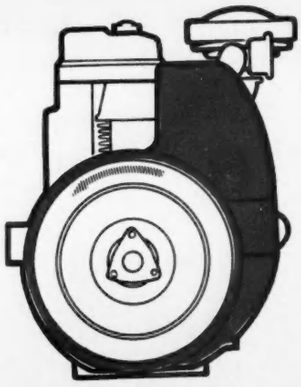


REVERSE ROTATION



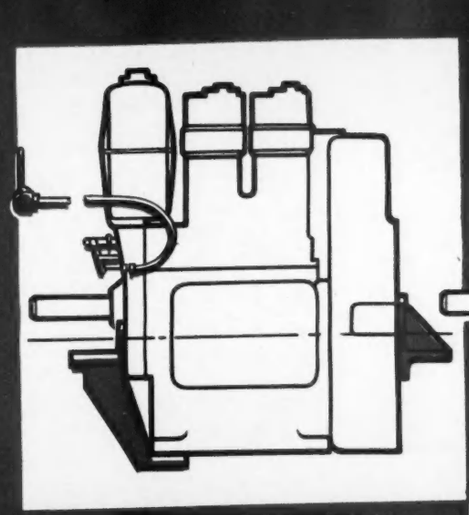


GENERAL ARRANGEMENT—LD3 & SL3
(Also showing electric starting)

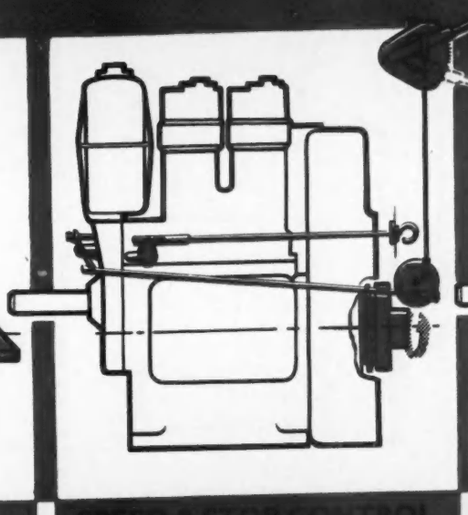


REVERSE ROTATION

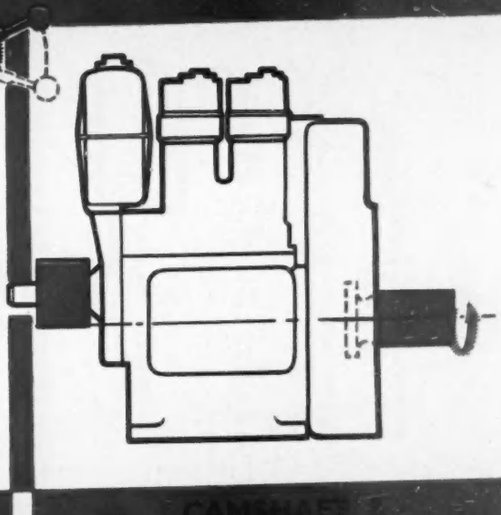
Accessories shown are as fitted to twin cylinder engines; a similar range is available for single and three cylinder engines.



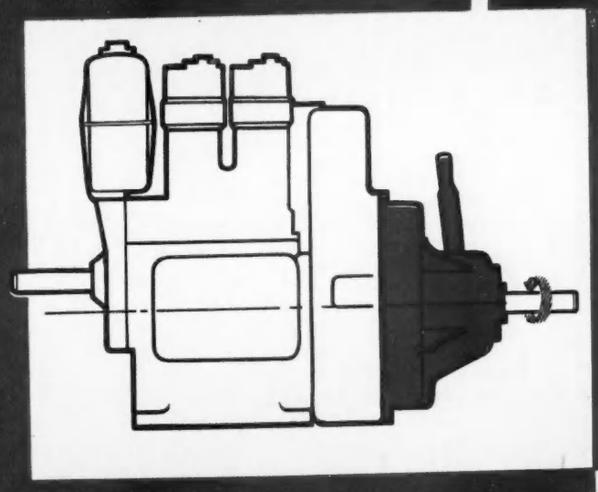
SPEED CONTROL HIGH LEVEL BEARERS



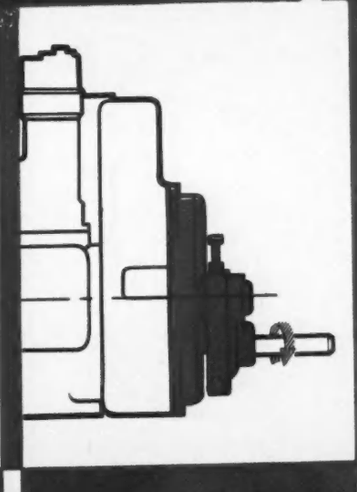
SPEED & STOP CONTROL FLEXIBLE COUPLING



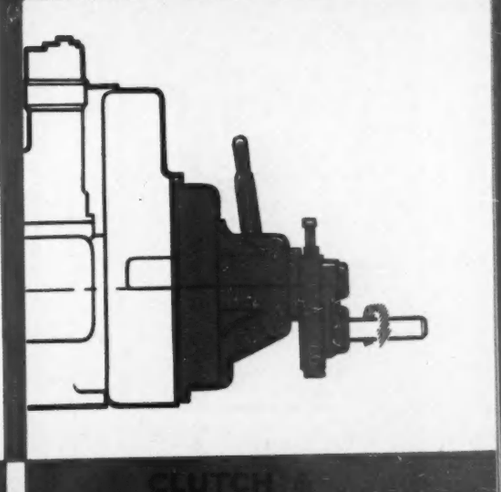
CAMSHAFT & CRANKSHAFT PULLEYS



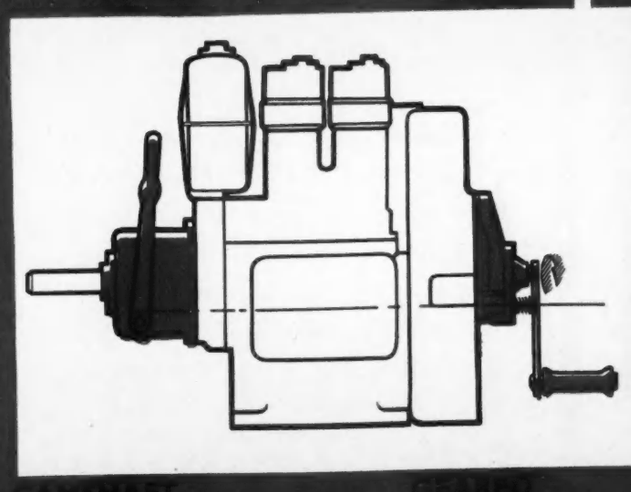
CRANKSHAFT CLUTCH



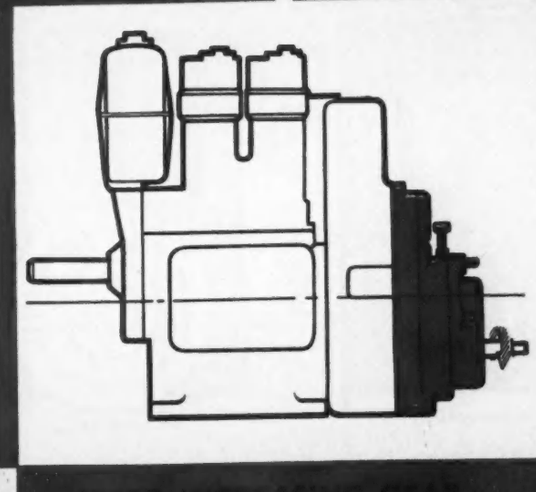
REDUCTION GEAR



CLUTCH & REDUCTION GEAR

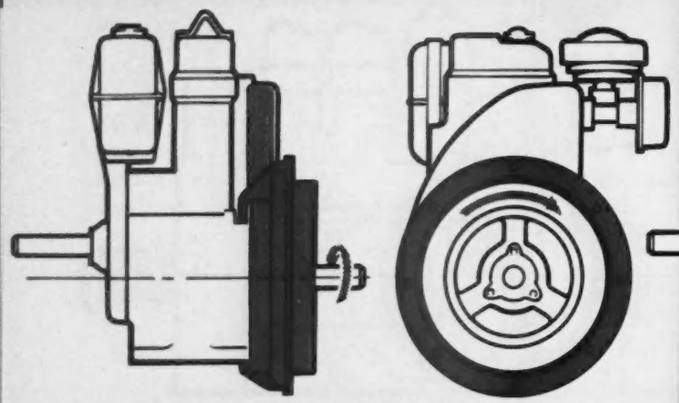


CAMSHAFT CLUTCH GEARED STARTING



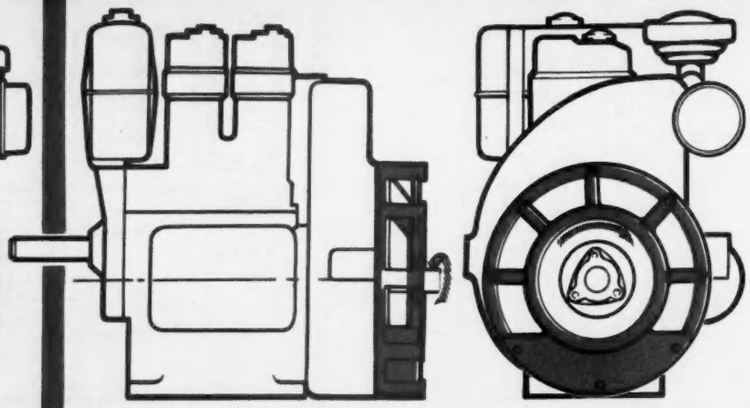
SPEED INCREASING GEAR

LISTER AIR-COOLED ENGINES TYPES 'LD' & 'SL'

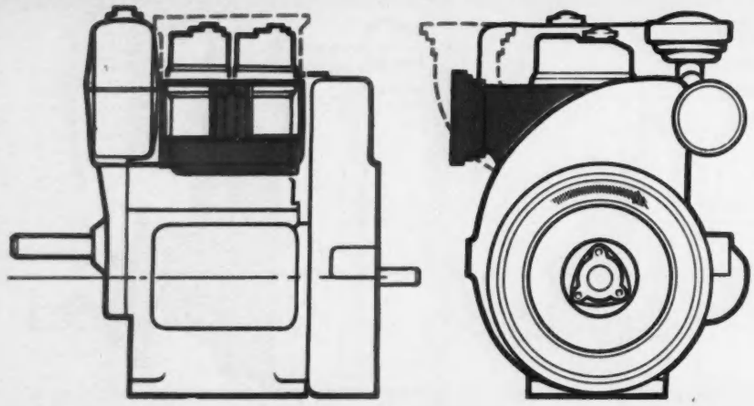


REQUIRED FOR LD1 & SL1 ONLY

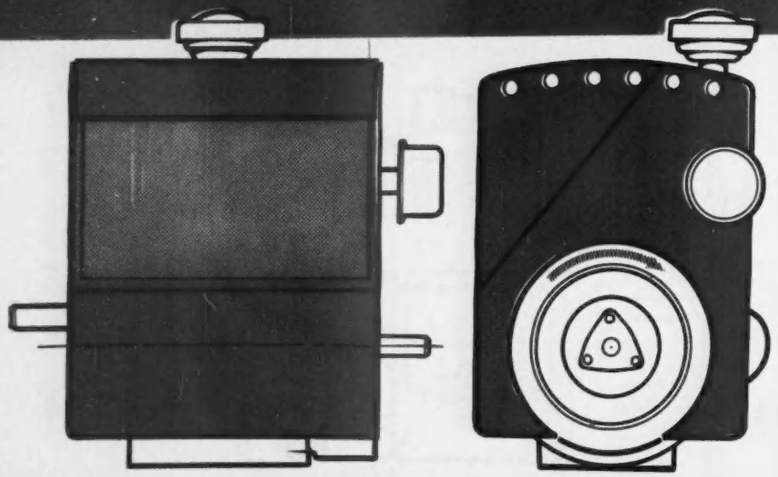
CLOSE COUPLED FAN SHROUD



S.A.E. ADAPTOR (No. 6 shown: Nos. 1-5 available)



DUCTING



SHEET METAL HOUSING

MANY OTHER ACCESSORIES ARE AVAILABLE INCLUDING:

Raised hand starting
Air thermometers
Alternative fuel tanks
Lubrication for long runs
Fuel lift pump
Water-cooled manifold
Remote stopping
Variable speed control
High level bearers

Full details of the complete range of accessories on request,

Reprints of these pages are available on application to
R. A. LISTER & CO. LTD.

For further details of these and other air-cooled diesel engines from 1½ to 36 h.p. or water cooled engine up to 1450 h.p. write to :

R. A. LISTER & CO. LTD

Dursley, Gloucestershire. Phone: 2371 Grams &
Cables: Hackney Dursley. Telex 43-220
London Office: Imperial House, Kingsway W.C.2.
Phone: TEMple Bar 9681.

# of our technical advice service?

Our files are already bulging with case-histories of remarkable improvements in performance, production and economy, as a result of visits by our Technical Representatives. Many of Britain's large engineering industries are constantly making use of this Service, which includes advice on Drilling, Reaming and Milling—in fact most methods of metal removal. And it's free!

Make sure you are using the best tool for the job, and the best method of application. Save time and money—use our experience.

DORMER

THE SHEFFIELD TWIST DRILL AND STEEL COMPANY LIMITED
SHEFFIELD ENGLAND

DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS

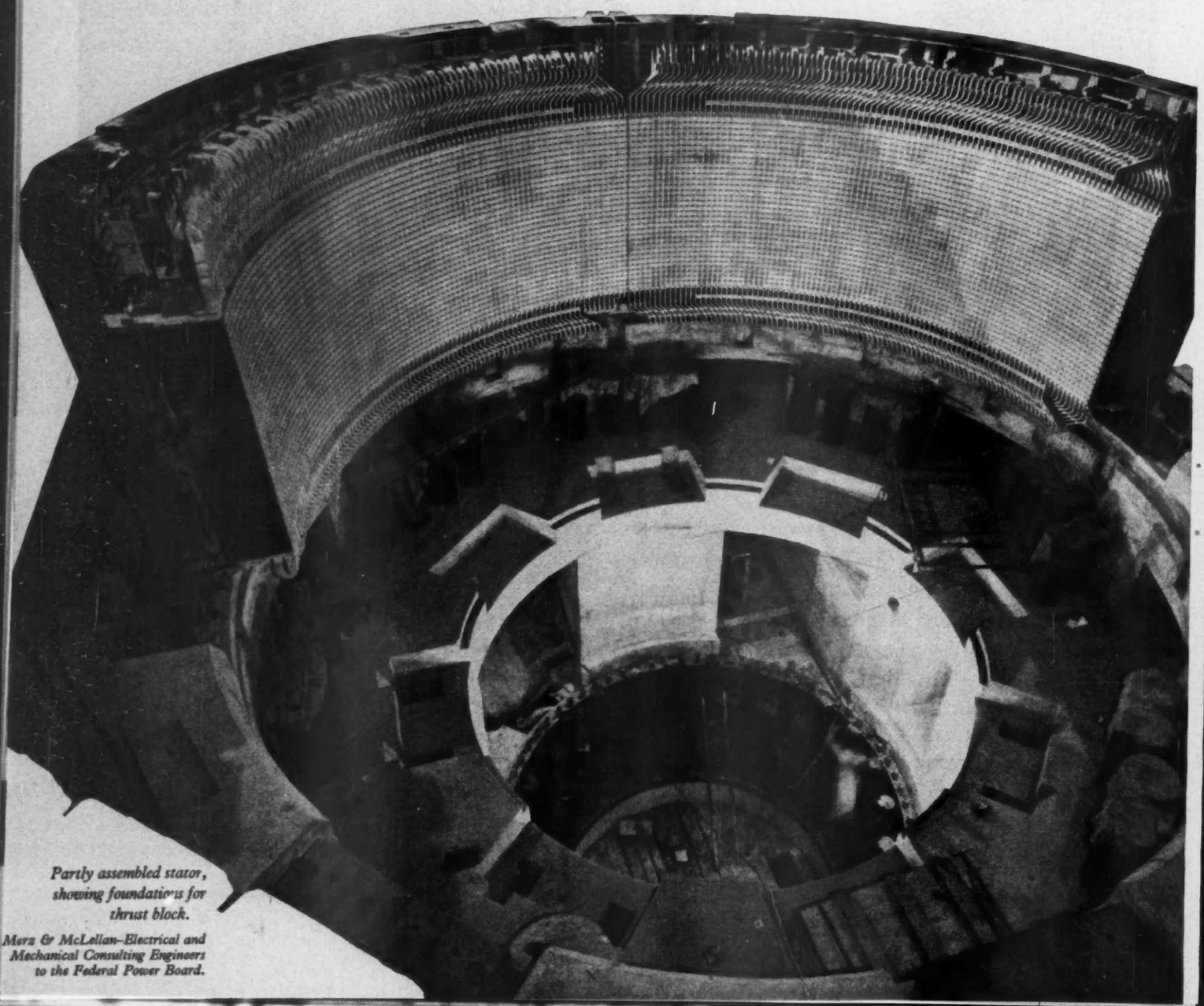
D

KARIBA—Electrical

THREE HUNDRED MILES downstream from Victoria Falls, where vast power goes to waste in a magnificent display, the waters of the Zambesi are being harnessed to supply electricity to the whole of Northern and Southern Rhodesia. The world's largest man-made lake, with an area bigger than the whole of the county of Kent, will store sufficient water power to generate 8½ million MWh of electricity annually. When the first stage of the plan is completed in 1962 six 100-MW generators will be in operation. By the early 1970's it is planned to raise the total generating capacity to 1,500 MW.

From Kariba this power will be distributed to the growing industries and cities of the Rhodesias and particularly to the Copper Belt.

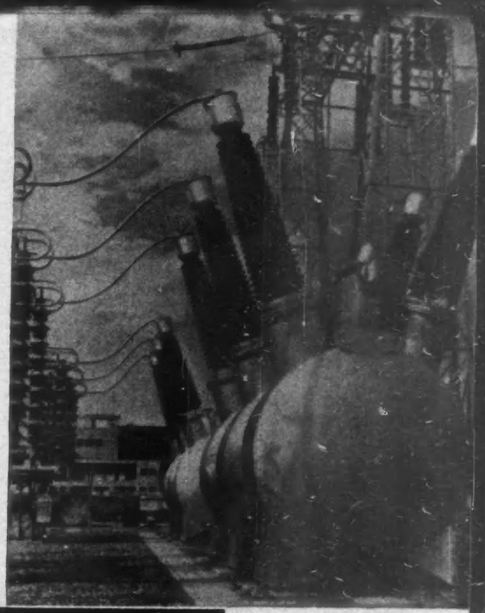
Much of the major electrical equipment for this great project is being supplied by AEI.



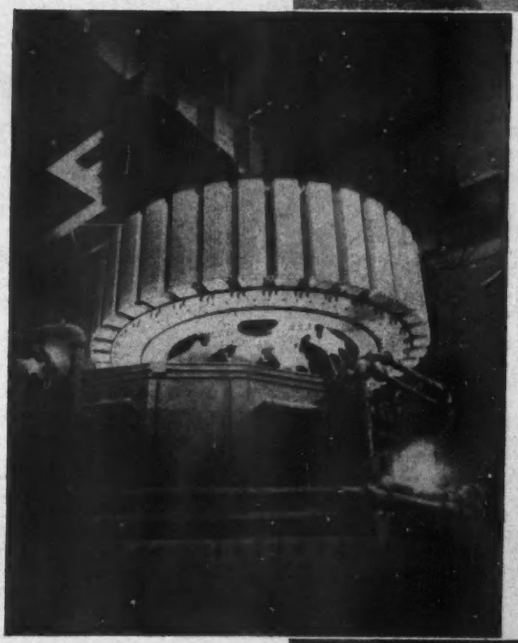
Partly assembled stator, showing foundations for thrust block.

Merz & McLellan—Electrical and Mechanical Consulting Engineers to the Federal Power Board.

Engineering on the Grand Scale



330 kV 7,500 MVA circuit breakers at Kariba switching station.



One of the six 100-MW generator rotors being lowered into its stator.

AT THE HEART OF THIS TREMENDOUS SCHEME are the six 100-MW AEI generators—the largest hydro-electric generators in Africa. Power is distributed at 330 kV which is the highest voltage to be used in the Southern hemisphere. For switching this power at Kariba and at the six sub-stations in Northern and Southern Rhodesia, AEI is to supply 25 oil circuit breakers, over 100 isolators and ancillary equipment.

AEI contracts also include the provision of 50 miles of cables, including control cables, co-axial and telephone cables and lead-covered cables for the underground power station.

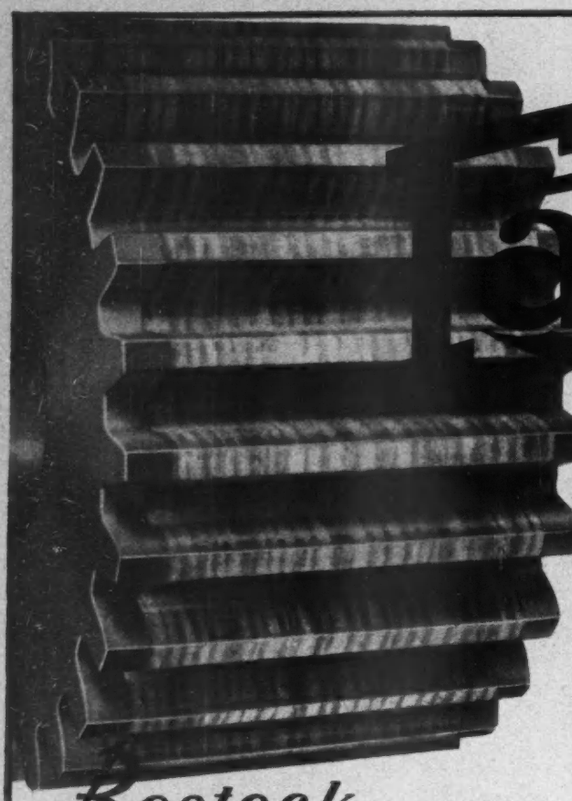
A section of the 330-kV switchyard at Kariba showing the equipment to control the feeder to Lusaka and Kitwe in Northern Rhodesia. The dam can be seen below.

AEI

Associated Electrical Industries Limited

33 GROSVENOR PLACE, LONDON, S.W.1

Mechanical Consulting Engineers to the Federal Power Board.



Fabroil

Silent GEARS

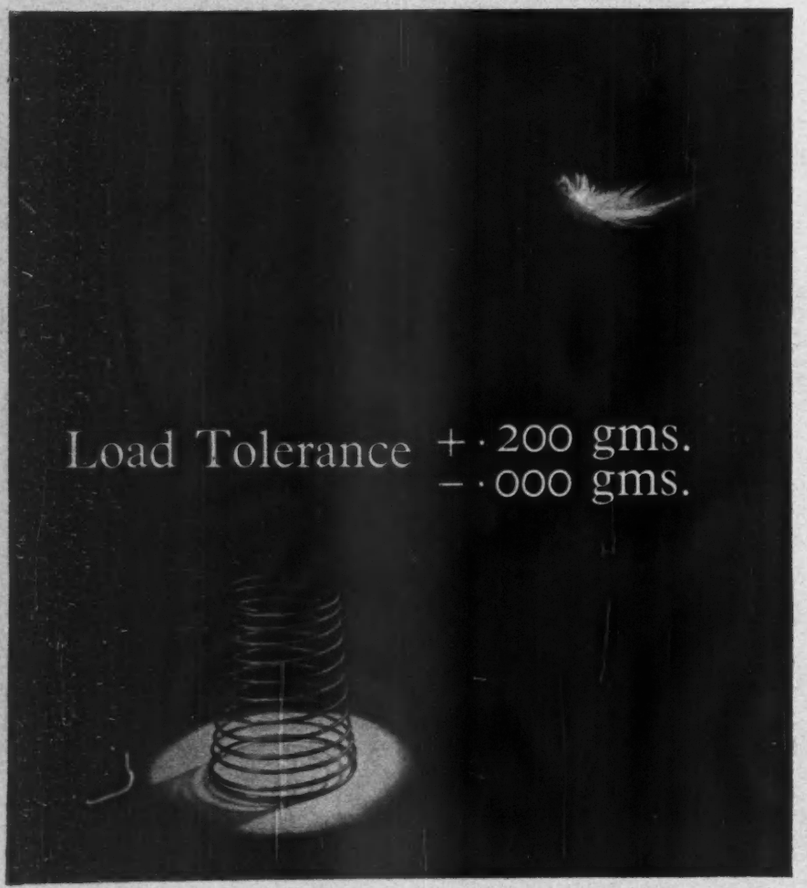
To ensure minimum friction and noiseless running, the choice of material for non-metallic gears is of great importance; such gears must have hard, smooth-wearing surfaces, and must possess great strength, elasticity, and shock-absorbing powers. Fabroil gears possess these qualities to a pre-eminent degree; and are far superior to gears of raw-hide, paper and other materials.

SEND FOR CATALOGUE & PRICE LISTS

Bostock & Bramley LTD

ODONTIC WORKS, STALYBRIDGE

Telephone STALYBRIDGE 3232/3
Telegrams "ODONTIC" STALYBRIDGE



FAMOUS FOR SPRINGS SINCE 1821

Meticulously produced to the most rigid specifications for a world-famous concern, this precision spring purpose-made by Riley has to meet precise linear dimensions under varying loads, with tolerances as low as ·200 Gms.

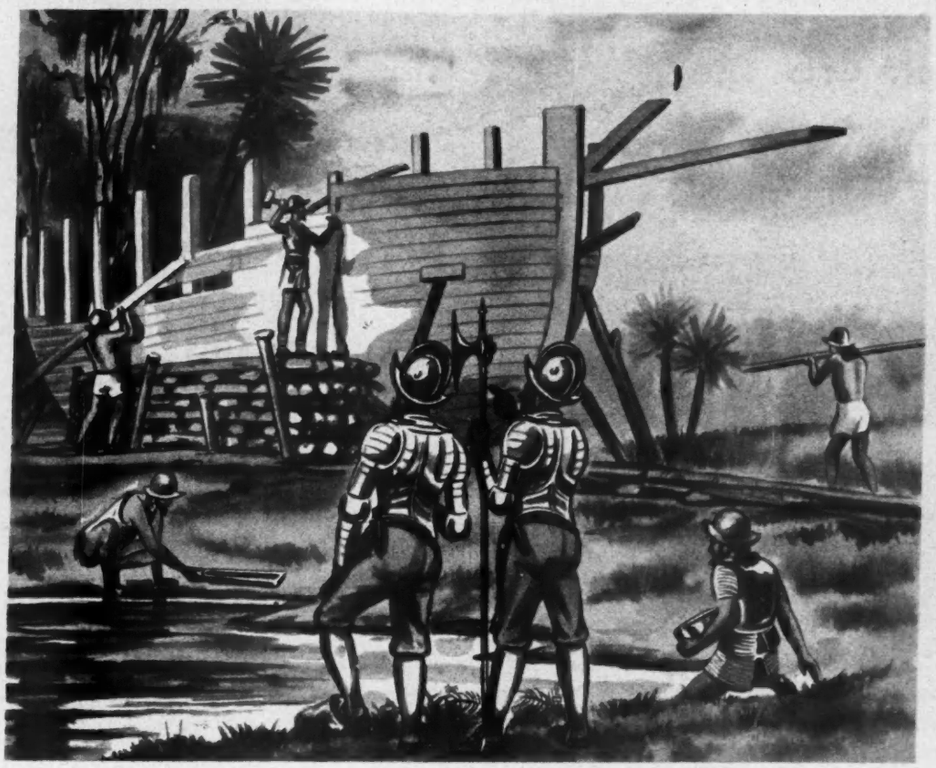
Such accuracy can only be achieved under the most carefully controlled manufacturing conditions. Every spring is tested (in most cases under actual working conditions and temperature) to the highest standards — Riley standards — which ensure a product of the finest uniform quality.

Springs by Riley are famous throughout the world wherever the ultimate in precision is the only acceptable qualification. Many try to reach these high standards, but few approach them.

There are no finer springs than Springs by

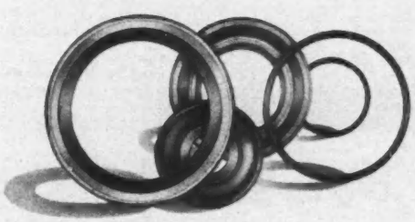
Riley

ROBERT RILEY LTD., MILKSTONE SPRING WORKS, ROCHDALE. *Tel: ROCHDALE 2237 (5 lines), Grams: 'RILOSPRING' Rochdale Telex 63-151*



The Spaniards were the first to make use of oil. They found it in surface pools around the coast of North America and they discovered that, mixed with mud, it provided a wonderful caulking medium.

The discovery of oil provided a solution to the problem of lubrication but it also provided a problem for those who had to use it in machines. It proved a difficult prisoner—and still does, but it can be checked and we, at Super Oil Seals, have the answer to any oil sealing problem.



SUPERFECT SUPER OIL SEALS & GASKETS LTD., FACTORY CENTRE, BIRMINGHAM 30.
Telephone: KINGS NORTON 2041

NORRIS BROS. LTD.
have teams available to undertake
DESIGN, DETAILING and DEVELOPMENT
in the following fields

- Aeronautical Engineering
- Chemical Plant
- Electrical Engineering
- Mechanical Engineering
- Mechanical Handling
- Model Making
- Nuclear Engineering
- Plant Layout
- Production Tooling
- Servo Mechanisms, Automation
- Special Machines and Projects
- Structure and Reinforced Concrete, etc.

53 VICTORIA STREET S.W.1
– TEL. ABBEY 6132 –

THERMOSTATIC VALVES *for Controlling*

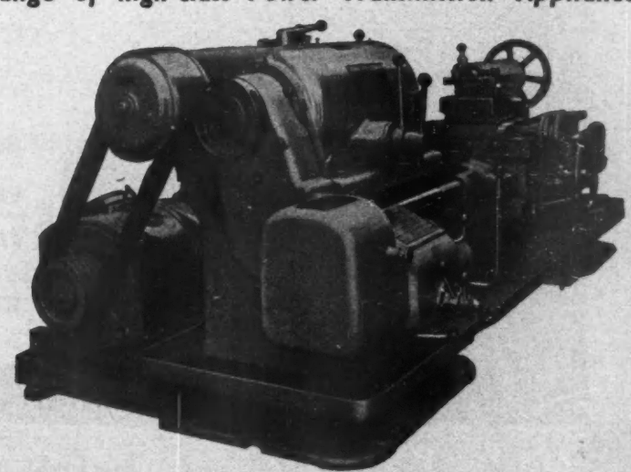
Steam Supply to Hot Water Calorifiers, Etc.

THE HORNE ENGINEERING Co. Ltd
35 PITT STREET, GLASGOW

We are designers and manufacturers of a full range of high-class Power Transmission Appliances

V–BELT DRIVES

The choice of the Machine Tool Industry

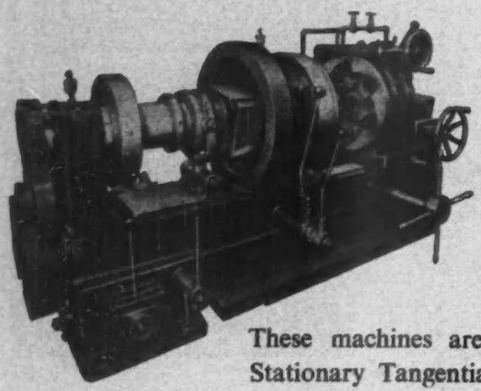


The photograph shows one of our drives mounted on a Denham Model SS8 heavy duty centre lathe.

R. HUNT & CO. LTD.
ATLAS WORKS · EARLS COLNE · ESSEX
Telephone: Earls Colne 202

HEAP'S Rapid Grip

THREADING AND CUTTING MACHINES



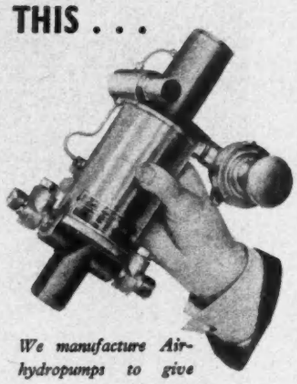
These machines are fitted with our Stationary Tangential Die heads and have been designed for production screwing of all sizes of pipes up to 12". They are in use wherever large quantities of piping have to be screwed, e.g. in Tube Works or in the Petroleum Industry. This type of machine can be supplied with 2-in., 4-in., 6-in., 8-in. and 12-in. capacity dieheads.

JOSHUA HEAP & CO., LTD.
ASHTON-UNDER-LYNE · ENGLAND

Hydraulic Pressure Testing with . . .

The JUNIOR AIRHYDROPUMP

Why labour at this? . . . When you can use THIS . . .



We manufacture Airhydropumps to give pressures up to 55,000 p.s.i.

The Junior Airhydropump costs approximately the same as a hand pump but has very definite advantages for individual hydraulic testing stations. It automatically gives the *exact* pressure required and will maintain this pressure indefinitely, leaving the operator both hands free. Six models are available, giving pressures up to 10,000 p.s.i. working from compressed air at 5 to 100 p.s.i. supplied complete with air-control valve and bench or wall mounting.

For full details send for leaflet AJ3'4.

CHARLES S. MADAN & CO. LTD.
VORTEX WORKS · ALTRINCHAM · CHESHIRE
'Phone : ALTRINCHAM 2702 'Grams : VORTEX, ALTRINCHAM. (Telex) TELEX 66-105 A/B ATLANTIC ALTCHM

C.M.12A

Solve your power transmission problem

IT

REDUCES
The peak amperage during starting
ELIMINATES
Starting shock and snatch
PREVENTS
Overloading electric motors and burning them out.
Breakage of fragile materials due to sudden starting shock.
Damage due to overload.
INCREASES
The life of belt and gearing.
PERMITS
Inching and rapid reversal.
SAVES
The cost of high starting torque motors.
RELIEVES
The motor of load.

with the amazing

DRY FLUID CENTRIFUGAL COUPLING

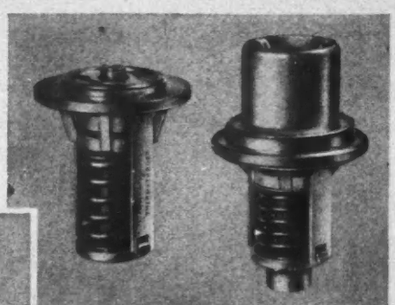
For technical information and assistance write to . . .

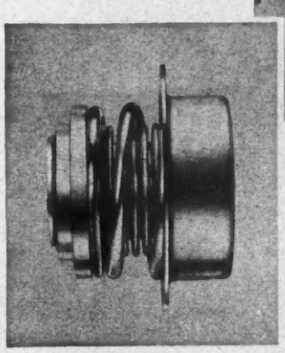
POWDER COUPLINGS LTD.,
A Member of the Specialloid Group of Companies
20 BLACK BULL STREET, LEEDS, 10
Telephone LEEDS 20936 & 31471/7

FOR RELIABILITY AND LONG LIFE —

it must be **Teddington**

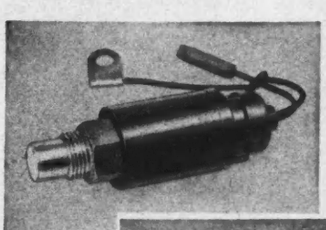
WAX-CHARGED COOLANT THERMOSTATS

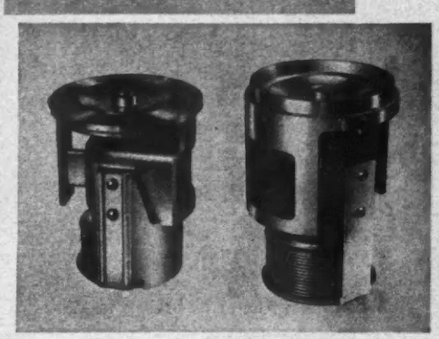




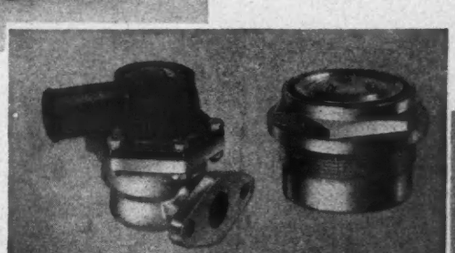
SHAFT SEALS

HEAVY DUTY TEMPERATURE AND PRESSURE SWITCHES

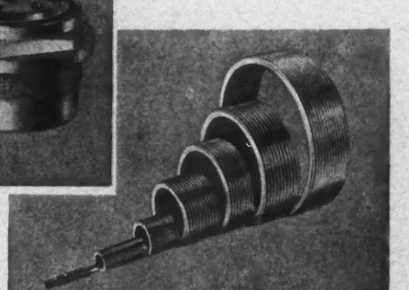




ENGINE COOLANT THERMOSTATS



PRESSURE RELIEF VALVES



SEAMLESS METALLIC BELLOWS

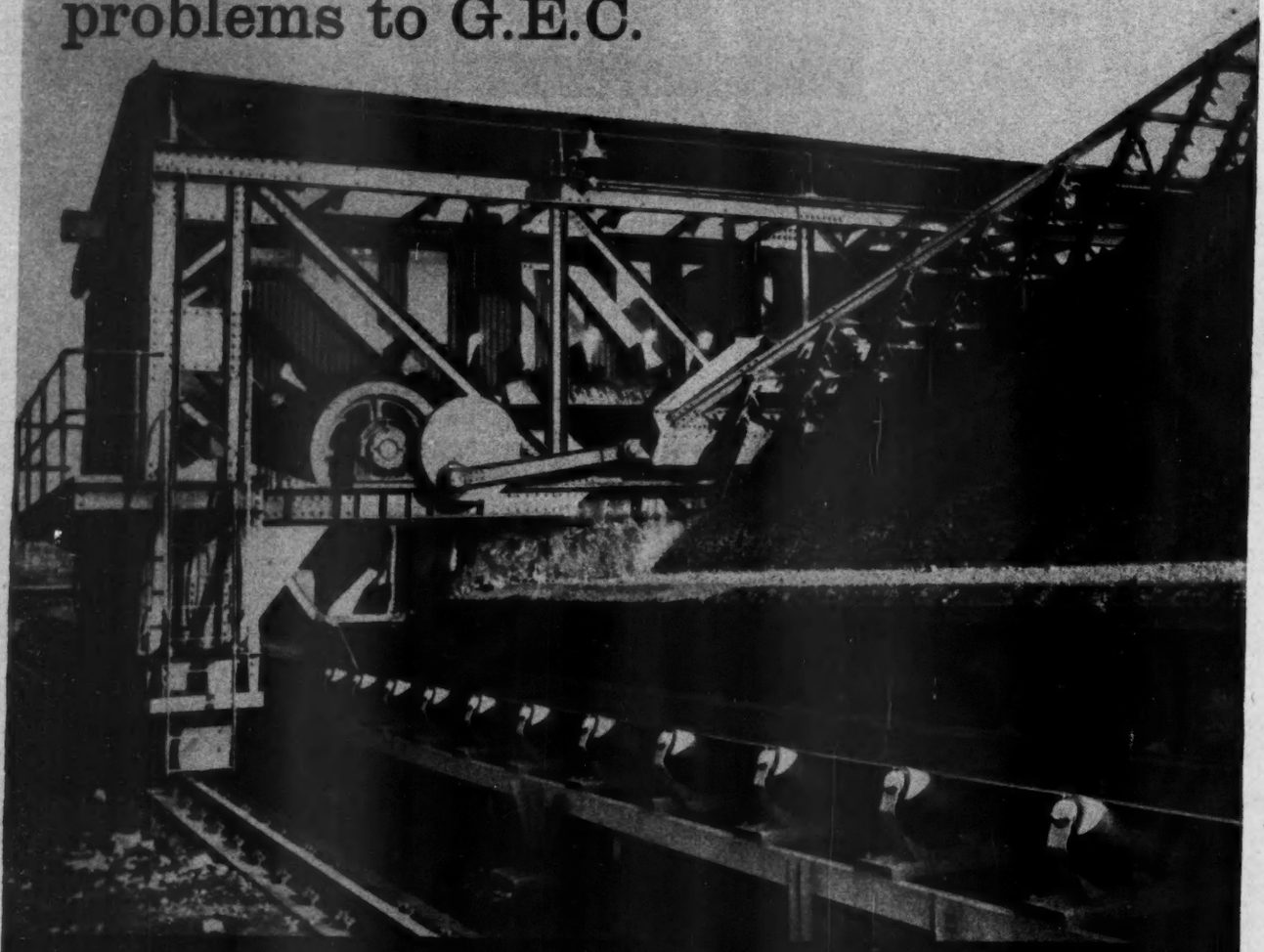
Every **Teddington** *product is backed by 30 years experience*

Ask for full technical details or call our Advisory Service

P. W. BAKER & SONS (SALES) LTD., PACKLESS GLAND DIVISION

TEDDINGTON WORKS, SUNBURY-ON-THAMES, MIDDX. TEL: SUNBURY-ON-THAMES 456

Europe, too, takes its materials handling problems to G.E.C.



In modern blast furnace practice the blending of ores and coals is often essential. Robins-Messiter reclaimers of the latest G.E.C. design are meeting this very purpose all over the world.

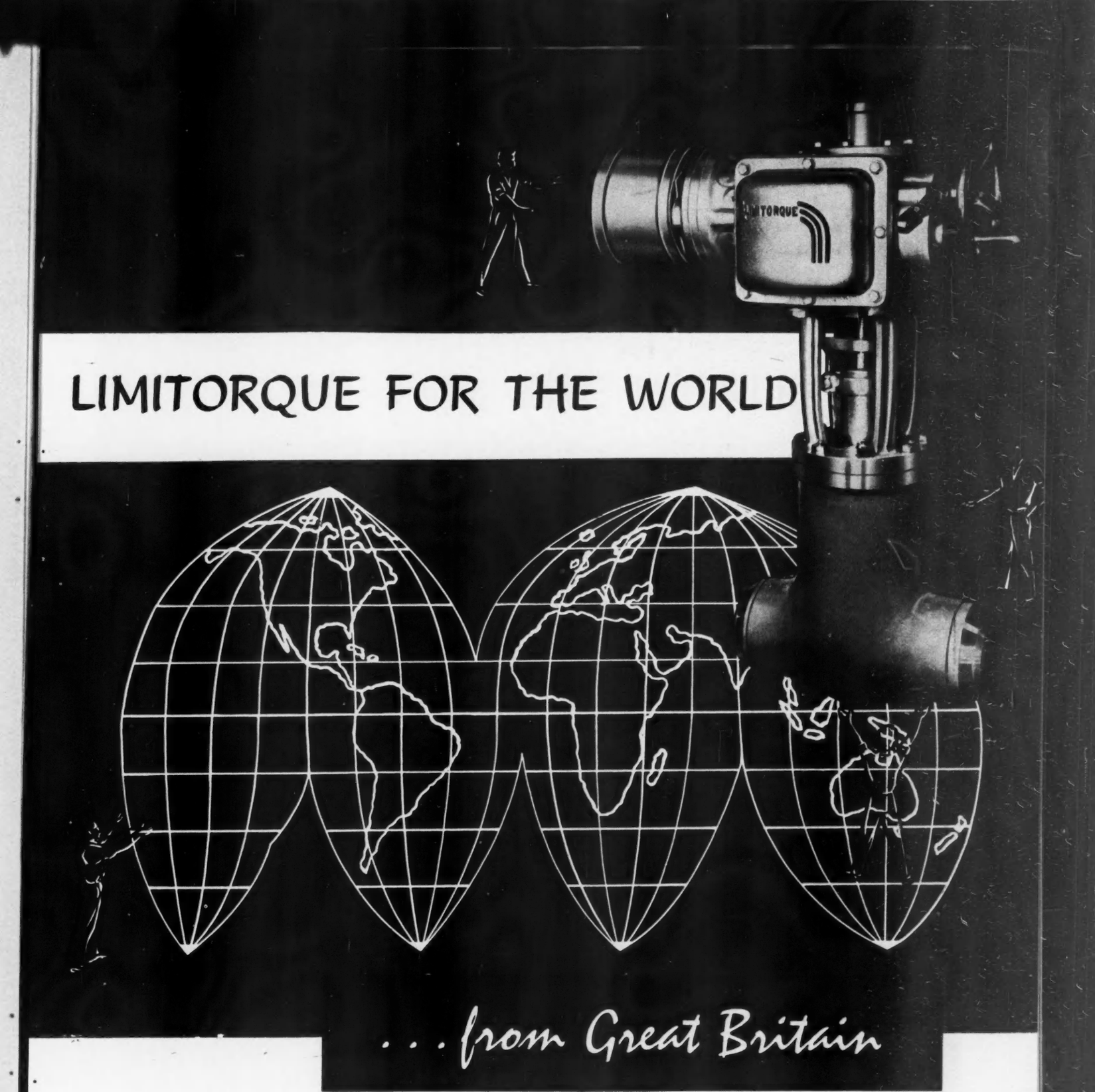
The G.E.C. Erith Works specialise in the design and manufacture of complete ore and coal preparation plants. This includes conveyors, screens, crushers, stocking-out and reclaiming machines, wagon tipplers, sampling plants, bunkers and buildings. In fact, G.E.C. installations, handling and processing materials to and from sinter plants are dealing with capacities of 3,000,000 tons per year or more.

The G.E.C. have installed complete ore handling plant in the U.K., Belgium, Italy, Spain, Yugoslavia, Africa, Australia, etc. They are always pleased to advise companies contemplating such systems—especially at the pre-planning stage.

G.E.C. OF ENGLAND

THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND
FRASER & CHALMERS ENGINEERING WORKS, ERITH, KENT

Designers and manufacturers of complete materials handling plant.



LIMITORQUE FOR THE WORLD

. . . from Great Britain

After many years, the famous ***LIMITORQUE*** valve actuator is now being manufactured in the United Kingdom and is available for world wide distribution.

LIMITORQUE is a fully automatic valve operator which controls and limits the opening and closing of all types of valves. It can be fitted to any valve in any position, it can also be adapted for use on existing manually operated valves.

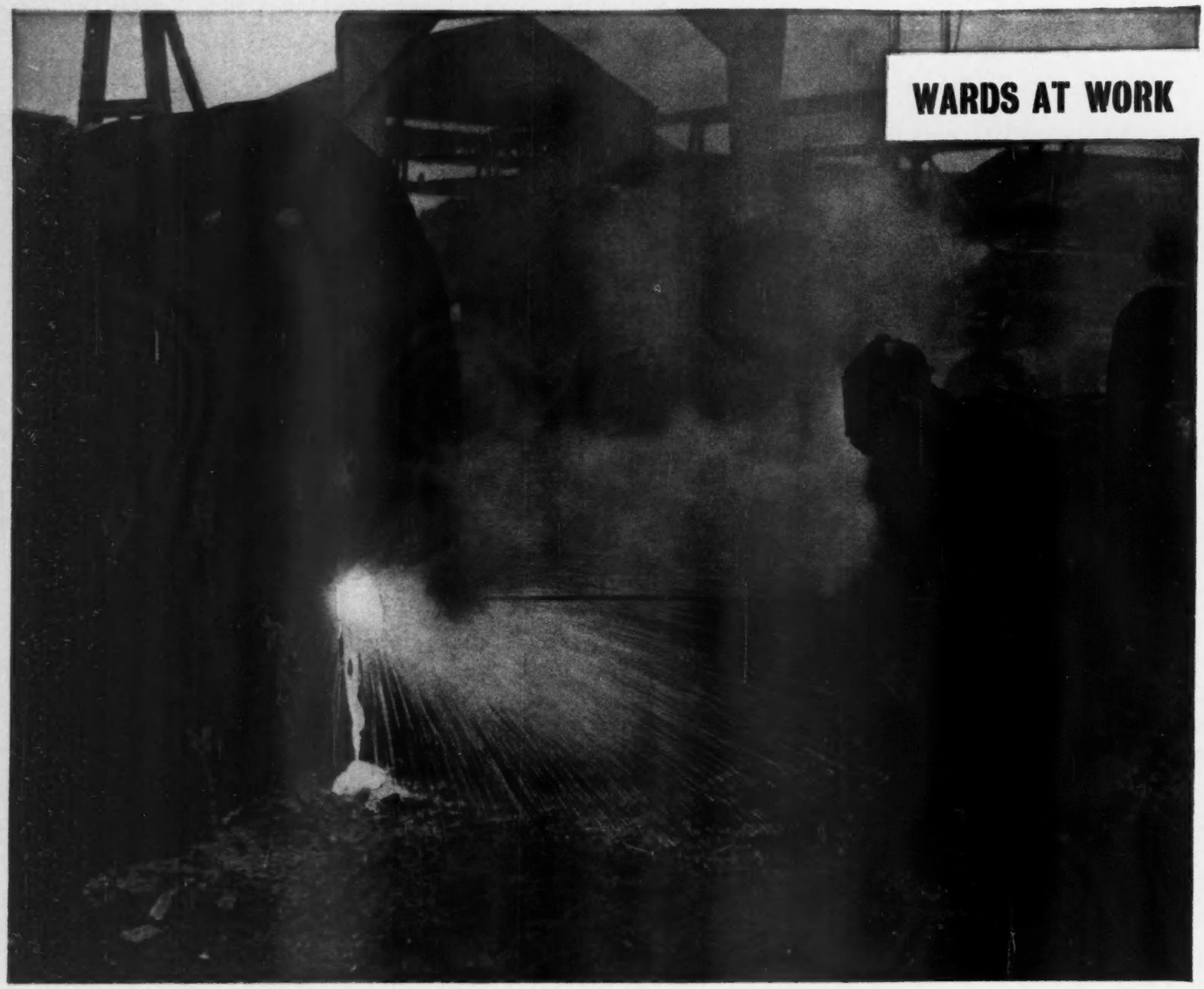
LIMITORQUE units may be operated by electricity, air, high pressure gas or hydraulic power.

Literature is available to principals on receipt of business card.

LIMITORQUE VALVE CONTROLS LTD

Newbury, Berkshire. Telephone: Newbury 1701 Grams: Limitorque Newbury

An associate company of Opperman Gears Limited



He turns base metal into gold!

No alchemist this, but a skilled scrapman in a Ward scrapyard. With his highly specialised experience, he can quickly prepare large masses of scrap for reduction to furnace sizes. Not only steel and iron, but all non-ferrous metals are handled too, both under strict metallurgical control. At scrapyards all over the country, equipped with the most modern plant, Wards handle thousands of tons of metals a day, and they are proud to be the leaders in this important industry.

Helping to feed the furnaces with carefully graded scrap is only one activity of the Ward Group of Companies whose products and services cover almost every branch of industry.

Serving Industry Around The World **THOS. W. WARD LTD**

Head Office: ALBION WORKS, SHEFFIELD. *London Office*: BRETTENHAM HOUSE, STRAND, W.C.2.

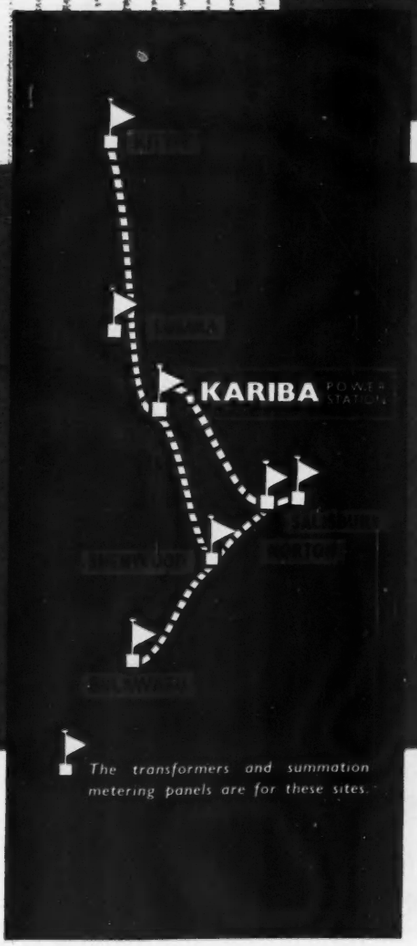
GP 93

An associate company of Upperman Gears Limited

One of the two Ferranti 120,000 kVA 330/234 kV auto transformer and series booster installations at the Kitwe sub-station.

FERRANTI at KARIBA

Ferranti Summation Metering Panels for the Kariba Power Station.



The transformers and summation metering panels are for these sites.

TRANSFORMERS

All the sub-station transformers for the Kariba Hydro-Electric Scheme are being supplied by Ferranti Ltd. They comprise two 120,000 KVA, 330/234 kV 3-phase auto transformers with series boosters, eight 60,000 KVA, 330/88 kV and four 60,000 KVA, 330/33 kV 3-phase double wound transformers. The transformer installations at Norton, Lusaka and Kitwe are complete. Work at Salisbury, Bulawayo and Sherwood is well advanced.

SUMMATION METERING

For the same scheme Ferranti Ltd. are supplying Summation Metering Equipment comprising: Precision grade integrating meters, Electro-mechanical summators, Printameter Demand Recorders and Suites of metering cubicles. These equipments will be used to meter six 100 MW generator sets at Kariba Power Station and also the supplies to the Transforming Stations at Kitwe, Norton, Salisbury, Lusaka, Sherwood and Bulawayo.

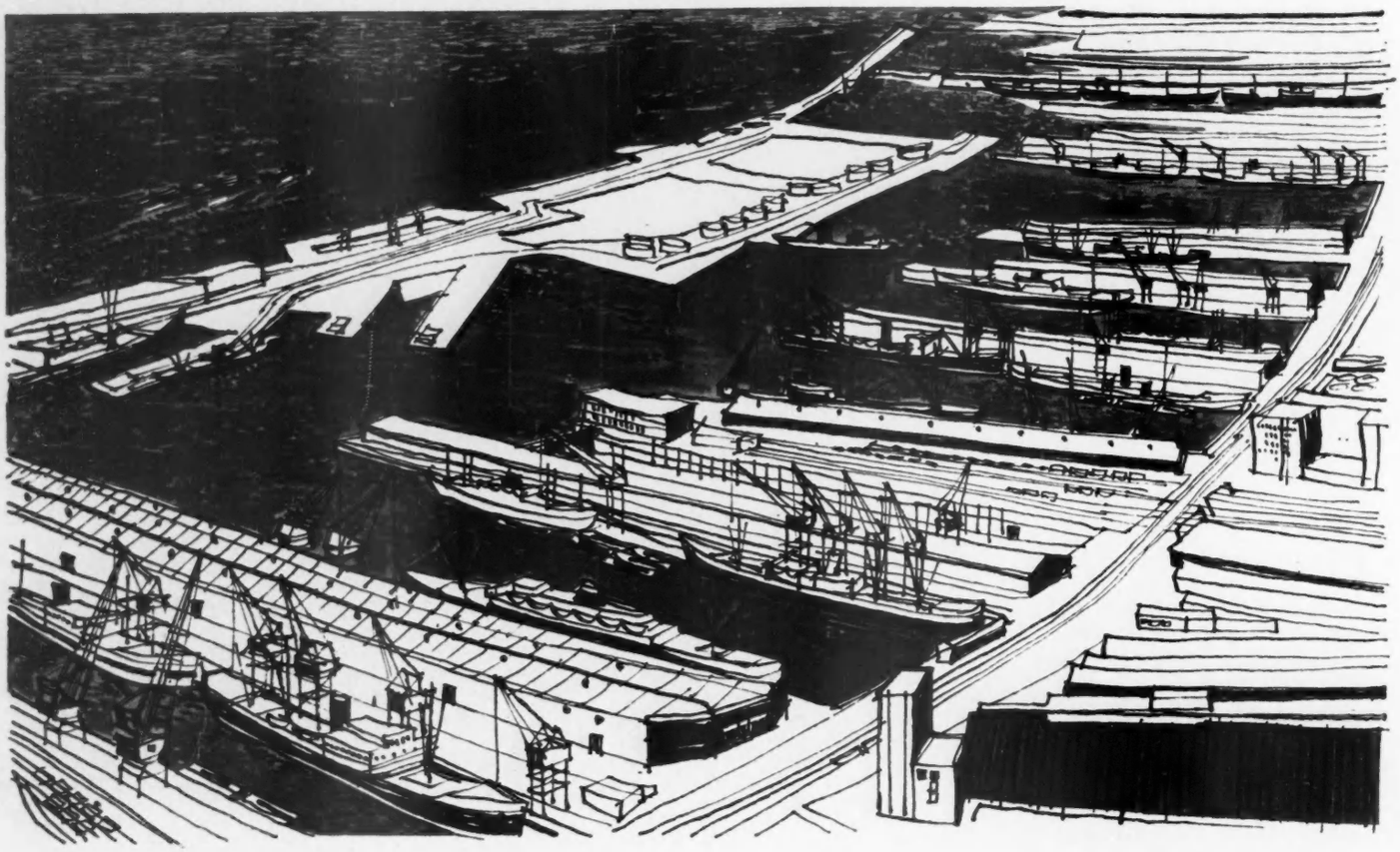
The consulting electrical and mechanical engineers are Messrs. Merz & McLellan.

FERRANTI LTD · HOLLINWOOD · LANCS · Tel: FAllsworth 2000
London Office: KERN HOUSE · 36 KINGSWAY · W.C.2 · Tel: TEMple Bar 6666

Ferranti

FG 307/2

Where there are docks and wharfs, ships and slips....



...there are **COWANS SHELDON** cranes

and equipment for the handling of materials and cargoes, vessels and rolling stock

Cowans Sheldon – a name recognised as specialist crane-makers for every industry – manufacture a wide range of cranes and equipment for marine duties all over the world.

DOCKSIDE LEVEL-LUFFING CARGO AND GRABBING CRANES
SHIPYARD FITTING-OUT CRANES · TRANSPORTER ORE & COAL GRABBING CRANES
DOCKSIDE WARPING & SHUNTING CAPSTANS · MARINE SLIPWAYS

CS

COWANS SHELDON

COWANS SHELDON & CO LTD

CARLISLE ENGLAND TELEPHONE: CARLISLE 24196-7

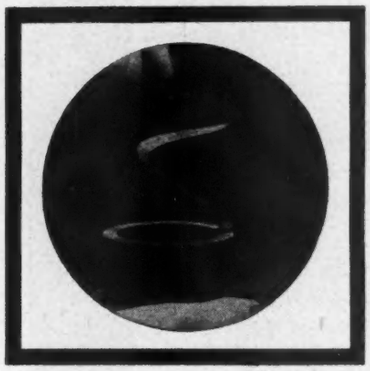
London Office: AFRICA HOUSE KINGSWAY WC2 Telephone: HOLborn 0268

P4025

THE NEW TECALEMIT RIBBON FILTER ELEMENTS

set a fresh standard of high efficiency filtration for

AIR–WATER–PETROL, DIESEL AND FUEL OILS–LUBRICATING, HYDRAULIC AND OTHER FLUIDS



Tecalemit Ribbon Filter Elements

Simple construction—Low cost—High flow rate—Easy to clean

The elements are formed of resin impregnated cellulose ribbon, wound helically and electrically fused into an open-ended cylinder. Innumerable microscopic orifices between the ribbons allow a very high flow rate, while retaining impurities on the outside or inside surfaces, according to direction of flow.

The standard range of diameters (in any length) covers most applications, and no other filtration material can so readily be adapted to individual requirements for filters, strainers, breathers or separators. Never before has such fine filtration been possible at such low cost and with such flexibility in use.

Tecalemit Ribbon Elements filter to maximum purity

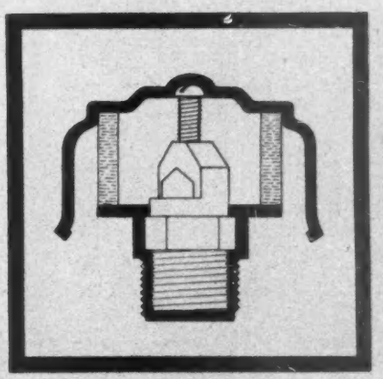
Tecalemit Air Breather Filters

(Incorporating Tecalemit Ribbon Filter Elements)

Cheapest—Most efficient—Cleanest to service.

Tecalemit Breathers act as ventilators to provide a free flow of clean air to hydraulic fluid, fuel and oil reservoirs. They give positive protection from airborne contamination to tanks, pumps, valves, cylinder and other engine components. Of the standard types, two are breathers with screwed bodies, and the third is a combined clip-on assembly of breather and filter cap. All are fitted with Tecalemit Ribbon Filter Elements.

Tecalemit Breathers provide pure air cheaply and efficiently



TECALEMIT

the authority on filtration

TECALEMIT LIMITED · (SALES E) PLYMOUTH · DEVON

THE MOST VERSATILE BUILDING CRANE IN THE WORLD

now manufactured in Britain

JULES WEITZ TOWER CRANES, which have established an enviable reputation in building and civil engineering applications, both on the Continent and in Great Britain and of which over 4,000 have been supplied, are now being manufactured in Great Britain by BABCOCK & WILCOX LTD., under the name of BABCOCK-WEITZ.*

To the established reputation of Weitz cranes, Babcock & Wilcox Ltd. are now adding their own experience of 50 years in the building of cranes of all kinds for world-wide service. BABCOCK-WEITZ cranes can be supplied in a wide range of types, facilitating the choice of the right crane for the job; with their proved advantages of full area-coverage and safer, faster, more accurate spot-placing of the load.

BABCOCK-WEITZ

FULL-SLEWING HORIZONTAL SADDLE-JIB

TOWER CRANES

BUILT IN BRITAIN by . . .

*By agreement with Jules-Weitz C.A.C.L.

BABCOCK & WILCOX LIMITED

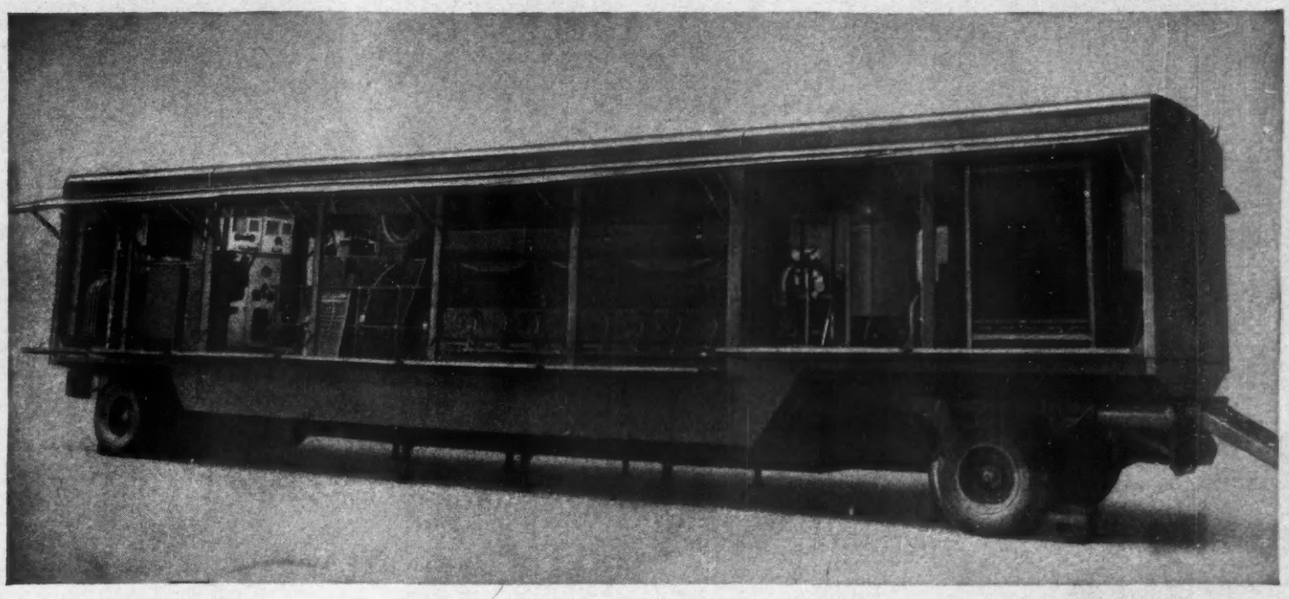
BABCOCK HOUSE, 209 EUSTON ROAD, LONDON, N.W.1. Tel: EUSton 4321

Sole Distributors in Great Britain:—

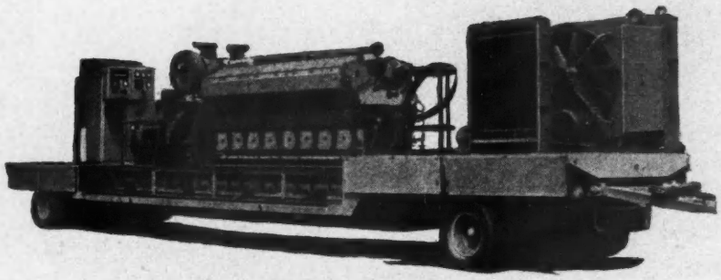
MACHINERY (CONTINENTAL) LIMITED

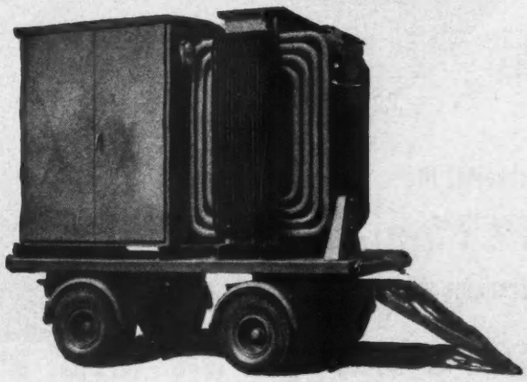
42 PARK STREET, LONDON, W.1. Tel: HYDe Park 1401

We are exhibiting at the BUILDING AND PUBLIC WORKS EXHIBITION, Lambton Park, Chester-le-Street, Co. Durham. June 15 to 25.
STAND NO. K71 BABCOCK-WEITZ TOWER CRANES. BABCOCK-RICHIER VIBRATORY ROAD-ROLLERS AND CONCRETE MIXERS.



Mobile Power for Venezuela





Four of the largest mobile generating sets ever constructed have recently been completed by Mirrlees, Bickerton & Day Ltd. for La Corporacion Venezolana de Fomento. Designed for use in townships and works where the local permanent power station is not sufficient to meet the demand, these diesel generators are capable of providing power for an average town.

The sets are made up of two trailers; one for generation the other for transformer duties. The power unit consists basically of a Mirrlees JVS.16 turbo-charged diesel engine with a continuous site rating at 900 r.p.m. of 1727 b.h.p. This drives a Brush 1200 kW generator, installed complete with switchgear and control panel.

The other trailer carries a Brush 1500 kVA Transformer which is capable of converting the full alternator output from 2,400 to 13,800 volts.

Mirrlees diesel power once again leads the way.

* **The photographs show:—**

TOP: *Complete Generation Trailer. Weight approx. 52 tons, 50 ft. long, 10 ft. wide, 12 ft. high.*

CENTRE: *Mirrlees JVS.16 diesel engine and Brush generator in process of being fitted on Generation Trailer.*

BOTTOM: *Transformer Trailer. Weight approx. 10 tons. 12 ft. 6 ins. long, 7 ft. 6 ins. wide, 12 ft. high.*

Mirrlees

diesels

MIRRLEES, BICKERTON AND DAY LIMITED · HAZEL GROVE · STOCKPORT · CHESHIRE

Telephone: Stepping Hill 1000 (15 lines) *A member of the Hawker Siddeley Group* *Telegrams:* "Mirrlees, Telex, Manchester"

IE24

off the cuff . . .

.78" ACTUAL SIZE

The New BURGESS V-4

* No larger than the average cuff-link
* New mechanism has mechanical life of at least 10 million operations
* Three types of solder terminals available
* Comprehensive range of auxiliary actuators

BURGESS MICRO SWITCHES

BURGESS PRODUCTS COMPANY LTD, MICRO SWITCH DIVISION, DUKES WAY, TEAM VALLEY, GATESHEAD 11
Telephone: Low Fell 75322. Telex: 53-229 London Office: 127 Victoria Street, SW1. Telephone: TATe Gallery 0251 Telex: 25601

The most effective
method of power
transmission is
Fenner
the V-belt drive
Smoothly, silently, effectively delivering power from prime mover to driven shaft, often within limited space, V-Belts perform a service in industry unequalled by any other method of mechanical power transmission. FENNER V-Belts and Taper-Lock Pulleys are
scientifically designed and manufactured by FENNERS to increase the effectiveness and adaptability of V-Belt
standard by which all
stock of all commonly
for your convenience at
COMPLETE V-BELT
'HAINSWORTH' VARIABLE SPE
DRIVES · TAPER-LOCK PULLEY
FENNER
J. H. FENNER & CO. LTD., HULL, YORKS
Branches at:
Belfast, Birmingham, Burnley, Cardiff, Cleckheaton, Glasgow, Hull, Leeds, Liverpo
Manchester, Newcastle-on-Tyne, Nottingham, Sheffield, Stockton-on-Tees, Sto

This was our 1952 advertising. Factory extensions in 1953, 1955 and again in 1958 show how YOU have proved this claim. Eight years later we can make it again because . . .

- Separate V-Belts have a resiliency far superior to any form of flat belting.
- The wedge action of the V-Belts in the grooves actually improves with length of service.
- Neither tension nor alignment have to be maintained precisely to get good working results.
- If a V-Belt should break, the remainder will keep the drive working until replacement is convenient.
- ALL your drives using the same belt size are covered for spares by a stock of no more than are used for one drive.

Remember that all V-Belts give long loyal service, but more Fenner belts reach pension age than any others.

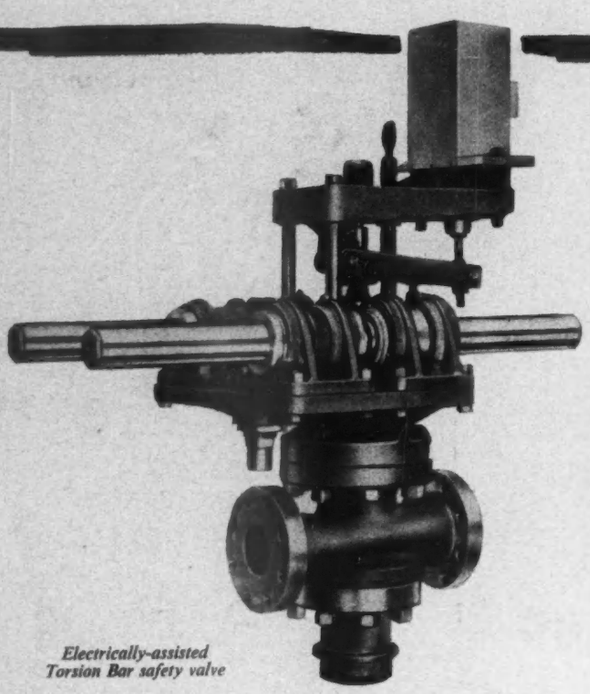
Fenner

J. H. FENNER & CO. LTD • MARFLEET • HULL

BRANCHES AT: BELFAST, BIRMINGHAM, BRADFORD, BRISTOL, BURNLEY, CARDIFF, GLASGOW, HULL, LEEDS, LEICESTER, LIVERPOOL, LONDON, LUTON, MIDDLESBROUGH, MANCHESTER, NEWCASTLE-ON-TYNE, NOTTINGHAM, SHEFFIELD, STOKE-ON-TRENT.

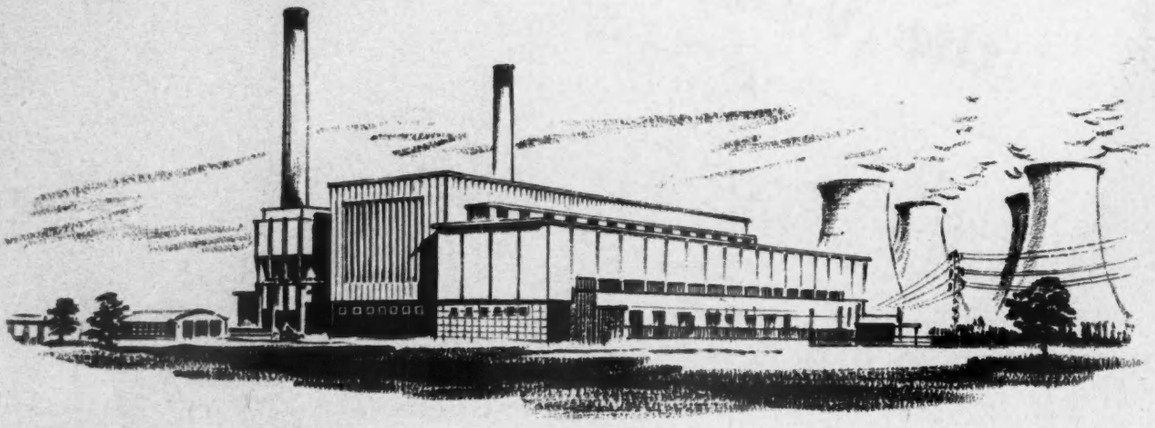
Catalogue 100/19 lists thousands of recommended standard drives. Send for it today.

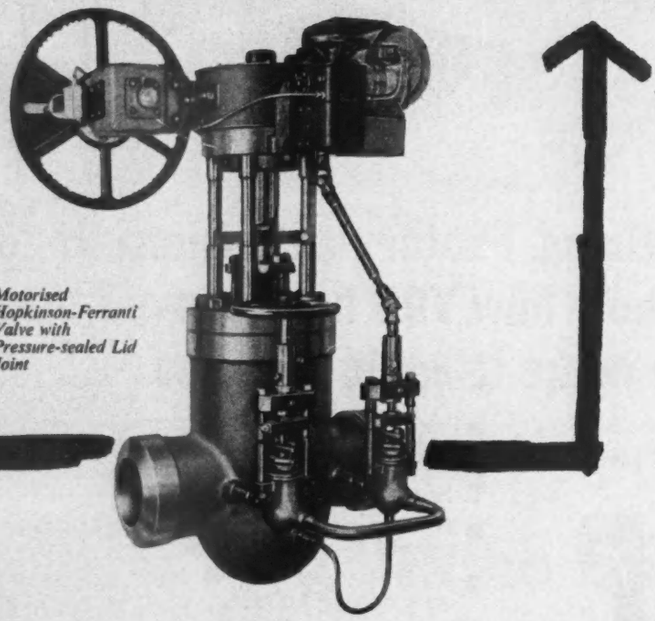
LARGEST MAKERS OF V-BELT DRIVES IN THE COMMONWEALTH



Electrically-assisted Torsion Bar safety valve

HOPKINSONS' HIGH PRESSURE VALVES AT HIGH MARNHAM





Motorised Hopkinson-Ferranti Valve with Pressure-sealed Lid Joint

Yet another important power station operating at very high pressures and temperatures (2450 lb/sq. in., 1060 deg. F.) relies on HOPKINSONS' valves. Our supplies to High Marnham include:-

Torsion Bar safety valves
"Hylif" spring safety valves
Combined stop and non-return valves
Non-return valves
Parallel-slide valves
Hopkinson-Ferranti valves
Electric valve controls
"Uniflow" valves
Automatic isolating valves
Pump leak-off equipment
Strainers. Steam traps
Safety valve silencers and expansion chambers, etc.

HOPKINSONS LIMITED • HUDDERSFIELD

LONDON OFFICE: 34 NORFOLK STREET STRAND W.C.2

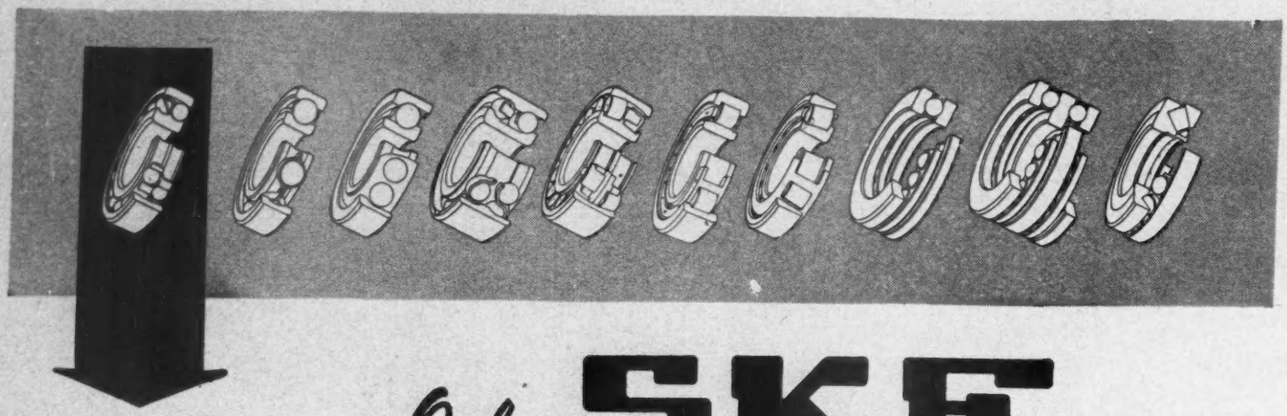
HV120

gives these reliability

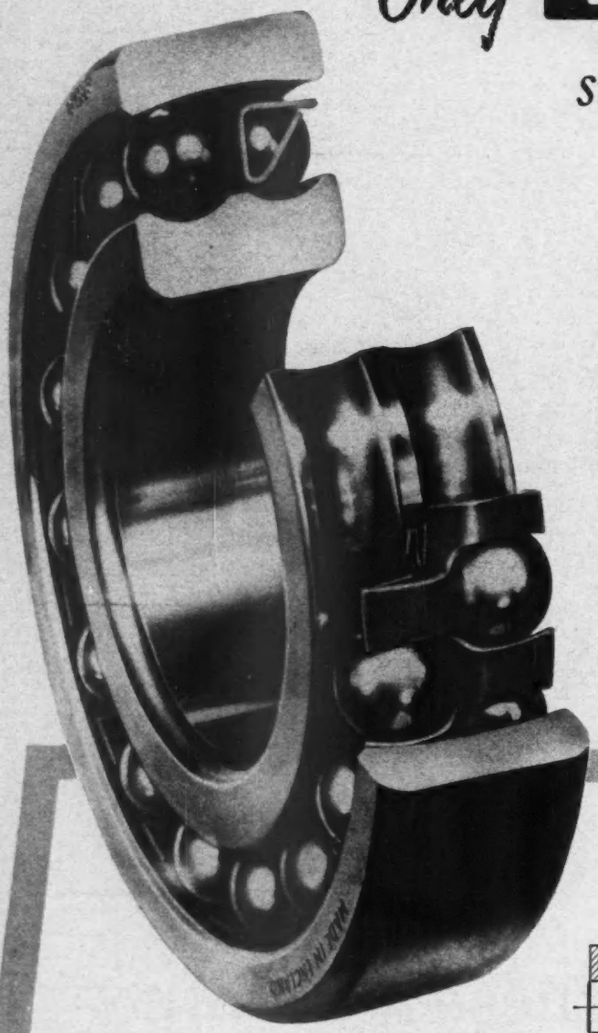
Quality Control at GKN means much more than inspection of the finished product: it means that minute inspection at every stage of production ensures that each process is faultlessly carried out. Quality Control begins with the raw material and ends only with the severest tests on the finished article. Since its adoption by GKN over 20 years ago, it has become the most important single contributory factor to the superb quality implied in the initials GKN.

GKN **GUEST KEEN & NETTLEFOLDS (MIDLANDS) LTD.,**

Screw Division, Box 24, Heath Street, Birmingham 18 · Telephone: Smethwick 1441 · Telex 33-239

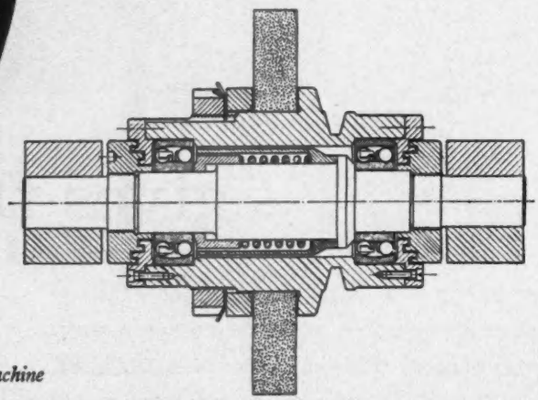


Only **SKF** *can offer such a wide selection of British made bearings*



The double-row self-aligning ball bearing, with its two rows of balls having a common sphered track in the outer ring, is completely self-aligning, and permits automatic adjustment to minor angular displacements of the shaft. Bearings of this type are particularly suited to applications where the speed is high and extra true running is required.

As the only British makers of all four basic bearing types—ball, cylindrical roller, taper roller and spherical roller—The Skefko Ball Bearing Co. Ltd. can offer comprehensive and unbiassed technical information on all bearing problems.



Bearing scheme for grinding wheel of leather shaving machine

THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

GI77

ENGINEERING Impact

of Record Orders for Machine Tools

THE machine tool industry, which a few months ago was constantly being exhorted to put its house in order, is now busier than ever before.

The new orders received in February were worth more than £13 million, a level £3 million higher than that of the earlier record month, November, 1954, and two and a half times the new orders received in February of last year.

The level of deliveries is still rising. In February, says the Machine Tool Trades Association, it was 9 per cent more than in January and 36 per cent better than the February of a year earlier.

Export orders were going up even faster; the increase over January was 27 per cent and over last February, 55 per cent. At the end of the month the home and export order book had increased to a value of £64 million.

And from the machine tool firms the story is that the demand is strong and the position in the weeks following the MTTA's figures is at least as good. In the Midlands the need is for more skilled men than show any inclination to move their jobs.

So vigorous an industry is well placed to take advantage of its opportunities. At home and overseas new plant and new tools are increasingly demanded for new industries, for expanding existing capacity, for replacement of the old.

New designs, improved production standards of existing machines, and closer contact with the user, especially abroad, in order to better the high standard of providing the tool that fits the user's need, all these are wanted if the flood of current orders for the machine tool industry is to be taken and is to lead to even higher fortune.

Falling Real Taxes Leave More for Plant

The proportion of the national income swallowed up by taxation has declined by almost a tenth since the post-war year 1948.

Then the percentage absorbed was 37; last year, in the most recent Treasury review, the figure was down to 29 per cent. Not that the revenue from taxation has declined. It has increased from 1948's £3,500 million to £5,500 million.

But despite this level of taxation the national income has risen from £9,600 million to £18,900 million over the same years.

In the same period profits tax fell from eight per cent of the total tax revenue to just under five. Surtax, varying only very little, moved from 2·8 per cent to 3·1, and income tax rose from 34·8 per cent of the total tax revenue to 42·8.

The outcome of all this is that companies which, although not enormous, have a substantial turnover are able to predict re-equipment and research spending costing millions, all to be raised from their own resources. The only thing wrong with that is that there is not far more of it. The burden of taxes still falls so heavily on some fast rising firms, whose engineering developments are of first degree importance to the nation, that for the simple continuance of their development spending they have to get themselves swallowed by larger units who have the broad spread of production to cover the costs.

It is still possible for the business high-priests of the American journal *Fortune* to point to the humble degree of the United Kingdom's expansion in the recent past and describe the country as one whose economy is distorted by a far too high level of taxation.

Recent Government pronouncements and the credit restrictions show every concern to prevent the present boom getting out of control. What would perhaps be more profitable in the long term would be simultaneously to allow more of the proceeds of the present activity to be retained for re-equipment and development.

Sticking out like a sore thumb from the history of taxes since 1948 is the imposition on "hydro-carbon oils." For 1948 and 1949 this was down at 1·6 per cent of the tax revenue. By 1952 it had been raised to 6·2 per cent: more than surtax and the revenue from wines and spirits added together.

In 1959 the tax on oils produced 6·8 per cent of the tax revenue, substantially more than profits tax which brought in 4·8 per cent. Exhortation from Government spokesmen for cuts in prices are common enough, and few have responded better than the heavy vehicle manufacturers.

If the Treasury inflicted a cut of its own—in the tax on petrol and oil—it would reduce manufacturers' costs, the transport industry's expenses and the private individual's cost of living.

Increasing Imports from the Soviet Union

Iron and steel and machinery played a large part in the increased British exports to the Soviet Union in the first quarter of the year.

Non-electrical machinery exported in the first three months was worth £6·3 million, almost three times the £2·3 million of the same period last year. Iron and steel exports, which were worth only £49,408 in the January-March period of 1959, rose in the quarter for which figures are now available to £2,100,000. In the same way chemical exports rose from £465,000 to £944,000.

The total of United Kingdom exports to Russia for the quarter was just over £11 million. The first quarter figure last year was £7 million. Imports from the USSR increased from £9·6 million to almost £12 million.

These are hardly increases on the scale that Mr. Anfimov, the Russian deputy trade representative in this country, was recently urging. The increase in turnover of Soviet-UK trade for the quarter is from £17 million to £23·5 million. Continued at the same rate for the rest of the year, it would mean another £28 million in Anglo-Soviet trade for the whole of 1960.

Set against the sort of increases the Russians would like to see in British purchases, in order to cover their own trading with the whole Sterling area, this is no more than a token. Tools, machinery, industrial equipment, even private cars, are on the list of products the Soviet trading bodies would like to see being bought by Britain.

Since the currency made available by these sales would be used for Russian buying of materials from the basic producers in the Sterling area, greater purchasing power would be created in those countries for the acquisition of British manufactured goods.

of Official Intervention and Industrial Advance

Whether the danger is of one political party's threats of further nationalisation, or of upsets in the state of the market by credit restrictions, there is no doubt such negative activities are unwelcome in industry.

Just how much industry has suffered from Government interventions is a subject where rather more information than exists would be useful. For the building industry, with three million people and a whole complex of manufacturers depending upon it, something more has now been produced.

Alarmed, possibly, by the ease with which the Radcliffe Committee proposed that the possibility of using building controls should be looked into, the National Federation of Building Trades Employers took action. Their study group to examine the implications of this suggestion has now reported. What the report describes, in violent fluctuations in work being done, in plant not fully utilised, in delays and difficulties, and in the key matter of training skilled men, adds up to an unhappy story that is of far wider implication for industry than that of building alone.

The chief executive of a great new plant for the manufacture of washing machines, or electric motors for refrigerators, knows the lasting disruption that follows a major credit squeeze. There is no strong suggestion that the most recent dose will have such an effect.

Skilled men paid off do not readily return from the factories that snapped them up. The building study group point out that serious fluctuations make labour recruitment difficult, just at the time that it is also increasing labour turnover. Inevitably some of the men who leave an industry in this state do not return. The building industry in particular experienced, after 1956, a real drop in the number of new, indentured apprentices.

All Equipped but Nothing to Build

Like many a successful industrialist before them, the civil engineering contractors of Great Britain anticipated that a serious need, in this case for modern roads, would have to be met and accordingly prepared themselves.

Since vigorous and frequent statements of road building intent were a staple of Government publicity the civil engineers were not to be blamed for thinking that their foresight would be rewarded.

The industry was full of constructive proposals. Now it must be difficult not to think of itself as jilted by a heartless administration.

If the weather allows, some £70 million should be spent on new road works this year. The Federation of Civil Engineering Contractors estimates that it has the plant standing idle and could find the men to do another £100 million worth of road building a year, given time to gear itself to the job. The chairman, Mr. J. Maurice Laing, reports that his organisation has drawn the Government's attention to the spare capacity which exists in the industry at a time when so many others are booming.

From the reply he has no hopes of a change in that quarter.

The Federation sees five main reasons why, among 41 major firms who have provided figures, there should be 1,652 machines suitable for road work standing idle, almost as many as the 1,751 employed on or committed to road schemes.

They are: the reduction of work because of the cost of money borrowed by local authorities, the existence of local councils' direct labour groups which cause reductions in work to fall heavily on the contractor, the rundown in opencast coal mining, the industry's own increased productive capacity and the expansion in equipment to deal with an expanded road programme which has not materialised.

On the first reason, the high cost of local authority borrowing, the figures are that while in 1952 the councils borrowed, from the Public Works Loan Board, 85 per cent of what they needed at rates between 3 and 4¼ per cent, last year they were only able to borrow 8 per cent of their needs from the Board, at rates between 5¾ and 6¾ per cent.

If the many warnings on what road traffic delays and casualties now cost, and will increase to, were to impel the Government towards a really major road programme the improvements would be by no means immediate. The road builders estimate that from the firm announcement to being fully engaged in all the extra work of which they are now capable would be a period of two years.

And they will not be keen to get started on airy talk. Plainly some of the road building firms have already once been bitten, and every day their unwanted plant stands expensively idle is another nip in the pocket.

and a Nation of Fires without Smoke

There is a good deal of encouragement for optimists in the report of the *Committee on Solid Smokeless Fuels*.

Its implications for the makers of equipment both for making the smokeless fuels and for consuming them are considerable.

A rise in demand is tentatively foreseen for open-fire fuels of 5 million tons a year by 1965.

Of the fuel producing industry's future plans, the committee says that supply and demand of the "specially reactive" fuels could be brought into balance by 1965. In the short term there may be a shortage of up to three-quarters of a million tons in 1962, unless some action is taken.

The action recommended is that the Gas Council, in collaboration with the National Coal Board, should consider increasing production of these fuels. The eight gas boards not yet producing such fuels should be asked to consider the feasibility of doing so.

Fuel Oil Blended to Close Tolerances

Fuel and gas oils are mixed accurately in Mobil Oil's in-line blender. The three stage system accepts wide variations in flow rate. Thus tankers can be loaded with oil made to any customer specification.

UP TO the end of the war, most of the blending of fuel oils was carried out at the manufacturing source by batch blending into storage tanks. To meet marine requirements, the products were well defined as Gas Oil, Bunker "C" and Marine Diesel, the latter being a blend of approximately 85 per cent Gas Oil with 15 per cent Bunker "C." For supplies to the industrial market the grades were defined by viscosity, and were confined in the main to 200 seconds Redwood No. 1, 900 seconds, and Bunker "C" at approximately 3,500 seconds; a total of five grades in all.

But producers and marketers are still called on to deliver intermediate specification grades depending on the requirements of public authorities and such people as individual shipping lines. Therefore, where several grades of fuel oil are to be held at strategic locations, the call upon tankage is heavy and represents one of the largest investments of capital for construction work in the marketing field.

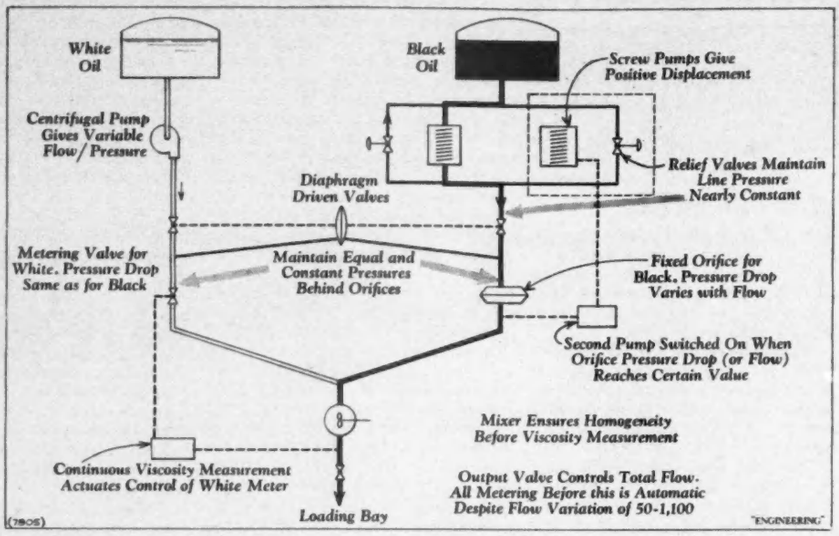
The introduction of in-line blending of fuel oils at the distribution points has resulted in a great saving in tankage, with its consequent reduction of capital investment per ton of storage, and at the same time has permitted the delivery to these distribution centres of two grades only, but in much larger consignments.

The intermediate grades, made up of a blend of the two base stock oils fall within the range of a light fuel oil and a heavy fuel oil. The permissible marketing range for each may be as wide as 100 seconds Redwood No. 1—a total variation in viscosity on the lighter fuels of up to 15 per cent. Mobil Oil Company, however, decided that a tighter control of viscosity, to within plus or minus 2 per cent, would benefit the customer because of reproducible viscosity, and himself because the viscosity could be held constantly at the upper limit of the permissible selling range. This would entail the minimum admixture of the more expensive blend stock—Gas Oil.

In the new in-line blender at Ellesmere Port, therefore, the aim is to mix a black fuel oil with viscosity up to 5,000 seconds Redwood No. 1, with a white gas oil, and to control viscosity to within small limits.

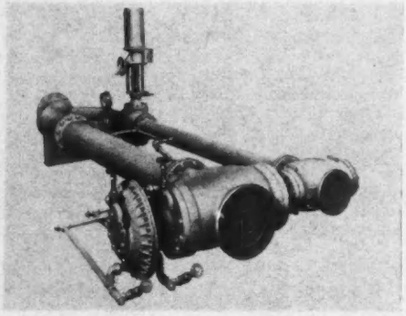
Running through the system from end to end, as in the diagram, there are two components coming from the pumps and entering the blending unit. Here the pressure of each component is automatically equalised by self-operated pressure balancing valves. The high viscosity black oil then passes through a fixed orifice while the low viscosity white passes through the metering valve which proportions the flow as required. A pressure difference sensing switch is fitted across the fixed orifice to switch on the second black oil pump when the flow reaches the maximum value of the first pump. Having got the two streams in more or less correct proportions, they are joined together and passed through the electric mixer. A sample is then extracted for comparison with a standard by the viscosity controller. This sends an electrical signal which readjusts the setting of the metering valve if there is any deviation from the desired viscosity. The blended product is then piped straight to the loading arms which are fitted with pressure switches to automatically start the pump when required.

The installation is designed for loading one or more tankers either individually or simultaneously, and when topping up the flow rate


White Oil
Black Oil
Screw Pumps Give Positive Displacement
Centrifugal Pump Gives Variable Flow/Pressure
Relief Valves Maintain Line Pressure Nearly Constant
Diaphragm Driven Valves
Metering Valve for White. Pressure Drop Same as for Black
Maintain Equal and Constant Pressures Behind Orifices
Fixed Orifice for Black. Pressure Drop Varies with Flow
Second Pump Switched On When Orifice Pressure Drop (or Flow) Reaches Certain Value
Mixer Ensures Homogeneity Before Viscosity Measurement
Continuous Viscosity Measurement Actuates Control of White Meter
Output Valve Controls Total Flow. All Metering Before this is Automatic Despite Flow Variation of 50-1,100
Loading Bay
(7805)
"ENGINEERING"

(Above) Flow of white and black oils.

(Below) Diaphragm controlled pressure equaliser. On the right hand pipe for white oil is the electrically operated metering valve.



is virtually zero. Hence the whole system must meter accurately over a wide range of flow rates, from 0 to 1,100 gallons per min on each blender line. The pumping system with this flexible output consists of a centrifugal pump for white, and a pair of Hamworthy positive displacement screw pumps for black. To give the screw pumps variable flow characteristics, they are fitted with relief valves which can take the full output.

The screw pumps are designed to handle 550 gallons per min of heavy oil viscosity 2,250 seconds Redwood No. 1 at 120° F, with a working pressure of 110 lb per sq. in, thus giving a total output of 1,100 gallons per min to each blender when both pumps are brought into operation. They are direct coupled to vertical motors rated at 70 b.h.p. running at 975 r.p.m. Vertical screw pumps were selected for their compactness in design, space saving and ease of maintenance, the pumps being removable from the pedestals without breaking any pipe connections. Steam tracing has been fitted round the pumps to ease starting in very cold weather.

The problem of mixing two streams of liquid together in certain volumetric proportions is not novel. The method used in the Mobil installation was developed by Fisher Governor Company of Iowa, USA, and incorporates modifications by Fisher Governor Company of Rochester in the United Kingdom, to enable it to handle high viscosity oils, up to 5,000 seconds Redwood No. 1.

It employs the principle of parallel metering of the two oils and arranges that the pressure losses across the two metering areas are kept equal. Since the viscosity of the heavy fuel changes rapidly with temperature, this component is metered through a fixed orifice of special design, in other words, the edge contour of which is such that the discharge coefficient remains reasonably constant over wide fluctuations in viscosity. The light oil component is metered through a variable orifice in the form of a metering valve of the sleeve and piston type.

The pressure balancing unit consists of two pressure regulating valves actuated by a common diaphragm, as shown in the illustration. Pressure tappings are taken just upstream of the fixed orifice and meter valve, respectively, and piped to either side of the diaphragm, the black through 2 in diameter pipe, and the white through 1 in. Travel of the backed neoprene diaphragm and the valves is 2 in, and the tube diameters are such that there is no instability. The pressure upstream of the two metering areas must therefore be equal, and since they have a common downstream pressure at the junction of the two streams, the pressure losses across these areas are kept equal no matter what the flow.

The blend ratio, and ultimate blend viscosity, is therefore obtained by direct proportion of areas across the metering devices. The blend ratio would depend on a hand setting of the metering valve on the white oil, unless a viscosity measuring device could be made to do this automatically. Mobil Oil Company have arranged for just this—making use of a Smiths controller described in ENGINEERING, 6 May, 1960, p. 631. The viscosity controller trims the setting of the metering valve by means of an electrical signal.

To avoid hunting of the metering valve, it was necessary to find the time response of the controller. From tests on the prototype, it was found that the controller took 10 seconds to indicate a 2 per cent viscosity change in the blended product. The speed of the electric drive was subsequently arranged so that for a 2 per cent change in viscosity, the time interval was slightly greater than 10 seconds.

Mobil set out to control viscosity to plus or minus 2 per cent. The efficacy of this three-stage design can be judged from the fact that actual viscosity control is within half this tolerance.

Aluminium Based Anti-Corrosion Coating

Among the more interesting exhibits at the recent Leipzig Spring Fair was that in the Hungarian section: a new process for protecting steel from corrosion by sea or fresh water. A specimen on show, taken from an all-welded ship after 11 months exposure to sea water and five months exposure to river water on the Danube, showed not the slightest trace of corrosion.

Called Kenderisation, after the name of its inventor, Tibor Kenderi, of Budapest, this process consists in the application to a very lightly grooved surface of a coating of spongy material which is resistant both to corrosion and wear, and then painting it over with a chemically stable compound which is unaffected by heat, and which produces a smooth surface. It is claimed that coated articles can be welded but should not be soldered. It is also said to offer steel surfaces reliable protection at temperatures of up to 700° C.

The material used for the anti-corrosion coating is based on aluminium. The following tests were carried out to compare Kenderisation with other anticorrosion treatments.

Test 1.—Identical steel sheets, with five different protective layers, were subjected to comparative corrosion tests under identical conditions. The tests were carried out in 3 per cent NaCl and 1 per cent HCl solutions kept in motion by an agitator. Observed rates of material loss were as follows:

Kind of protection	Loss in weight gm per sq. m per day
Kenderised	1·4
Red lead coating covered by zinc grey body colour	15·2
0·2 mm spray aluminium by metallising	51·1
0·2 mm spray aluminium by metallising, subsequently heat treated to give diffusion bonding	59·1
Metallised with aluminium, heat treated, and remetallised with 0·2 mm aluminium	82·8

Test 2.—Identical steel sheets with four different protective coatings:

(1) Kenderised coating.
(2) Red lead primer coating covered with zinc grey body colour.
(3) Approximately 0·2 mm aluminium layer applied by metallising.
(4) Aluminium metallised sheets subsequently saturated with paraffin.

These were subjected to each of six chemicals:

(1) 5 per cent NaCl aqueous solution, with plates inserted upright.
(2) 5 per cent NaCl aqueous solution, with the plates strewn with coal dust, graphite and charcoal chips.
(3) 5 per cent NaOH aqueous solution with plates inserted upright.
(4) 5 per cent NaOH aqueous solution, with plates strewn with coal dust, graphite and charcoal chips.
(5) 5 per cent NaCl and 3 per cent HCl aqueous solution, with plates inserted upright.
(6) 3 per cent NaCl and 3 per cent HCl aqueous solution, with plates strewn with coal dust, graphite and charcoal chips.

One group of specimens was tested for 48 hours, the other for 144 hours. The paint coatings were ruined by the alkaline solutions within a few minutes; they were resistant to salts and salty acids for not more than 20 hours. The specimens metallised with aluminium withstood the effect of the salt solutions for 2 or 3 days, but that of the alkalies for a shorter, and that of the salty acids for an even shorter time. The Kenderised sheets were completely unaffected either on the surface or edges.

Test 3.—Identical steel sheets with three types of protective coating:

(1) Kenderised coating.
(2) Fire zinced coating.
(3) 1 mm zinc layer applied by metallisation.

These were each subjected to two kinds of chemical agents:

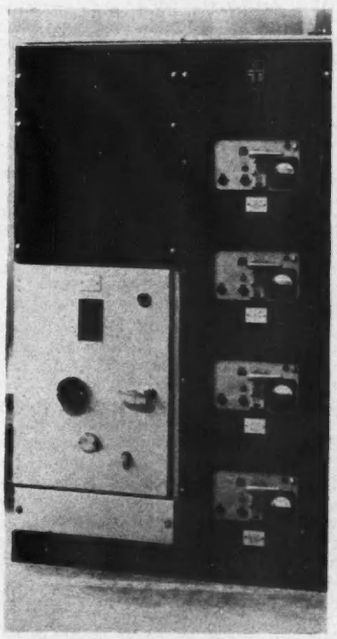
(1) 5 per cent NaCl aqueous solution.
(2) NaOH with a pH of 10 (corresponding to strongly alkaline water in the earth).

Specimens were tested for 72 hours or in another group for 120 hours. On the fire zinced specimens, both chemical agents had produced heavy corrosion, mainly along the lines of contact between the air and the water, after 72 hours. On the zinc metallised specimens, both chemical agents had produced heavy corrosion, after 72 hours, on their submerged parts and along the lines of contact between the air and the water, besides which, the solution had been sucked up in the sprayed layer and attacked it some 40 mm above the contact line. The Kenderised sheets were completely unaffected, even after 120 hours.

The marketing of this new process is handled by LICENCIA, the Hungarian State Company for the Commercial Exploitation of Inventions, Budapest 4, PO Box 172, Hungary.

Pvc-Coated Steel on Switch Cubicle

Switchgear cubicles, fitted as they are with start and stop, isolating and selector controls, are subjected to constant usage which very quickly marks and scratches a paint finish. Baldwin and



Francis of Sheffield have overcome this problem in their new range of multi-tier contactor switchgear by facing the front panels and facias of the cubicles with Stelvetite pvc-coated steel produced by John Summers. This facing is in light green and black.

John Summers and Sons Limited, Shotton, Chester.

Combustion Additives

Combustion Chemicals announce the introduction to industry of a range of combusion additives in powder form for use on the larger coal and oil-fired boilers. These are designed to counteract the effects of sulphur and other contaminants inherent in residual fuel oil, coal and pulverised fuel.

This firm has supplied many of the oil-fired power stations of the CEGB with similar products based on zinc metallics and these have been found effective in suppressing the acid dew point and in alleviating acidic smut emission.

On coal-fired boilers similar products have been found effective in breaking down heavy slag formation and preventing its further build-up in reducing the sulphur trioxide level in the flue gases, and in alleviating sulphurous stack emission.

In collaboration with Wallace and Tiernan, manufacturers of the chemical feeding plant required for the injection of powdered additives into the combustion zone, Combustion Chemicals are now able to offer a comprehensive service to industrial installations, backed by country-wide technical service and supply facilities.

Combustion Chemicals Limited, 33 Dorset Square, London, NW1.

Fire Resistant Paint Swells

Another paint has joined the happy band of coatings whose job it is to put off the evil day when we will go up in smoke. This is Albisaf, made by Albi-Willesden under licence from Hadfields (Merton). The product is a ready mixed paint which can be applied by brush, roller or spray to fibre board, timber, plywood or chipboard, and in particular to the glossy surface of hardboard, without pretreatment. Albisaf has been certified Class 1, surface spread of flame, BS 476: 1953. Its one of those which swells.

Albi-Willesden Limited, 6 De Vere Gardens, London, W8.

Plate it with Bright Platinum

Johnson Matthey have now made available a stable platinum plating solution from which bright, heavy and coherent deposits may be obtained. This bath, known as DNS platinum plating solution, is based on a complex sulphatodinitrito-platinous acid, and patent applications covering electrolytes of this type have been filed in a number of countries.

The bath is acidic, and may therefore be used successfully on electrical components and on printed circuits. Platinum from DNS solution can be deposited directly on to copper, brass, silver, nickel, aluminium and titanium. For deposition on tin, zinc, cadmium or steel an undercoat of silver or nickel is necessary.

Desposits from the new bath are bright and lustrous at all thicknesses and no polishing is required. Electrographic tests have shown no evidence of porosity in deposits up to 0·001 in in thickness on polished copper. Above this thickness some slight evidence of cracking may be observed. Microhardness tests on deposits give values of 400 to 450 VPN.

The DNS platinum plating solution is supplied as a concentrate containing 10 gm platinum per 100 ml of solution. For general use this should be diluted to 5 gm platinum per litre. Glass, earthenware or plastic tanks should be used.

The character of the deposits remains unchanged in the temperature range 30 to 70° C, but the recommended temperature is 50° C. At a current density of 5 amp per sq. ft and at 50° C, the deposition rate is 0·0001 in in two hours. At this rate very accurate control can be exercised over the amount of metal deposited, and for the majority of applications these conditions represent the best compromise of efficiency with economy.

A faster rate of deposition can readily be achieved by using a solution containing 15 gm platinum per litre at 20 amp per sq. ft, again at 50° C. In these conditions a thickness of 0·0001 in will be deposited in 30 min.

No agitation is required in using this bath. Where necessary, plating can be confined to specified areas by masking with a chlorinated rubber paint. Insoluble anodes are used in the process, and these should be of platinum. The anode surface area is not critical.

Johnson Matthey and Company Limited, 78 Hatton Garden, London, EC1.

Plain Words

By Capricorn

IT is commonly assumed that the research and development necessary for equipping a nation with modern armaments lead indirectly to the greatest advances in other branches of engineering. It is even argued that if anything approaching disarmament were to come into effect, the whole pace of engineering generally would slow down.

I am very disturbed by this assumption. Surely there are other ways of maintaining the speed of development? What could we do, given the vast sums normally spent on Blue Streaks and such-like weapons that come and go as quickly financially as ballistically?

Everything that one thinks of as a substitute seems almost tame by comparison. Very worthy and useful but not formidably challenging. In this issue of ENGINEERING there is a report on the analysis of railway coach design. Why wasn't this work done earlier? Why is other work of that kind not pressed ahead more vigorously? Apparently the nationalised industries, like private enterprise firms, are surprisingly short-sighted and short-term in outlook when they think about research and development.

In the absence of weapon development, what other possibilities are there? Personally, I would like to see a big research programme to develop a substitute for casting as a method of creating shapes in metals. Fabrication by welding is really only an alternative method which happens to be more convenient in some cases.

There is no difficulty in thinking of existing branches of engineering on which large sums could be spent with reasonable justification. Even so, it is difficult to conjure up near-impossible concepts which would tax science and engineering to the limit.

It is difficult to rid ourselves of that primitive instinct by which fear is the sharpest spur to human action. Must engineering, too, be spurred on by human fear? Mere competition is not enough: it produces better washing machines but it has to develop into international fear to inspire the most cunning forms of engineering.

The difference between armaments and peaceful products is that armaments are developed through competition that is technical whereas peaceful products are produced by competition that is economic. In one case there is little thought of the cost; in the other, cost is the basic consideration. If, then, the Americans and ourselves wish to preserve progressiveness in engineering in spite of disarmament, we must be prepared to isolate selected fields of engineering from the ordinary economy of the country.

Political factors encourage fabulous armament developments, but would pigeon-hole the report of a preliminary study of a transport system that could revolutionise the economy of the country.

The speed of engineering development is governed by political forces.

Letters to the Editor

Channel Tunnel Survey

SIR, Your note entitled "Channel Tunnel Vagueness" (ENGNG., 29 April '60, p. 571) correctly states that cross-channel traffic in 1958 and 1959 was considerably greater than that forecast by the study recently presented by the Channel Tunnel study group. This prompts you to make the amazing statement that "If this was the accuracy for only one year ahead of the calculations, what meaning can be attached to the group's estimate for 1980?" The answer is, a great deal.

The main purpose of the traffic survey, undertaken jointly by three research organisations (The Economist Intelligence Unit, London; SETEC, Paris; and DeLeuw Cather, Chicago) commissioned by the study group, was to arrive at longer-term traffic forecasts on which the revenue-earning power of a tunnel—and hence, ultimately, its profitability—could be assessed.

As with all forecasts of this kind, those shown in the tunnel survey were deliberately based on the most conservative assumptions. Higher traffic forecasts would not have been inconsistent with the basic data (for example, national income, car registrations) used by the authors of the survey for their calculations. But higher forecasts would doubtless have encountered a chorus of criticism as being too optimistic. The fact that traffic has increased faster in 1958 and 1959 than predicted strongly suggests that the prospects for a tunnel have improved since the forecasts were made.

Yours faithfully,
H. GEARSON.

The Economist Intelligence Unit,
22 Ryder Street, London, SW1.
4 May, 1960.

Skyscrapers Into Airports

SIR, Your editorial flight of fancy on "Vertical Take-off and Air Transport," shows a woeful lack of appreciation of the noisiness of modern aircraft (ENGNG., 15 April '60, p. 501).

Assume that the height of your landing platform is stepped up to, say, 500 ft. A Comet 4 take-off at full power at a height of 500 ft produces beneath it a noisiness of 510 N. The unit "N" (Noy) is subjective, and is a measure of the noisiness of a sound in the same way that the sone is a measure of the loudness of a sound.

The Minister of Aviation has placed a limit of 110 N for jet aircraft over "main built-up areas." As a recent article in your journal suggested that VTOL aircraft will produce considerably more noise locally than the present conventional silenced (*sic*) jets, you propose, in effect, that the noisiness at ground level near your landing tower shall be well over five times that which the Minister at present considers reasonable for a built-up area.

The only advantage which would come from the adoption of your proposal would be that the House of Commons, near which you are going to place your tower, would repeal the law licensing the nuisance of noise from aircraft, sections 40 (1) and 41 (2) of the Civil Aviation Act, 1949, as soon as the first VTOL aircraft left it.

Yours faithfully,
H. R. BROADBENT.

The Dower House,
Harlington, Middlesex.
8 May, 1960.

Diversifying Industry in the North East

SIR, My Board, the Tees-Side Industrial Development Board, has followed the series of articles which you are publishing currently on engineering growth and have been interested to read the article relating to the North East of England and particularly to the references to Tees-side (ENGNG., 8 April '60, p. 478).

I should, however, like to inquire whether the author, Mr. H. J. Novy, has anything further to say about Tees-side's export trade, that is, the export of iron and steel, of chemicals and of capital engineering plant for iron and steel works and chemical works and for the world's oil industry? And also about its connection with petrochemicals and nuclear engineering?

Since Mr. Novy visited Tees-side, Messrs. House and Fullerton have published *Tees-side at Mid Century* (Macmillan, London). This publication is sponsored by the Tees-Side Industrial Development Board, the Tees-Side and South-West Durham Chamber of Commerce and the North East Industrial and Development Association. In that publication, there is confirmation (if that were necessary) that Tees-side is the most favoured of the British estuarine regions, because of the amount of land available for industrial development. Your contributor refers in his last paragraph to the diversification of industry in the North East. Would he agree or care to comment upon the conclusion of the authors of *Tees-Side at Mid Century* about diversification (p. 439-441)?

Yours faithfully,
A. STOCKWELL,
Secretary.

Tees-Side Industrial Development Board,
Town Hall, Thornaby-on-Tees.
6 May, 1960

Midlands to Make More Cars

SIR, In his interesting article on "Engineering Growth in the Midlands" (ENGNG., 6 May '60, p. 612), Mr. H. J. Novy rightly concludes that in this area, with its shortages of space and labour, the main hope of industrial growth lies in greater productivity. That, indeed, is the object of the £49 million expansion plan which the British Motor Corporation announced in January—to obtain increased productivity and reduced time cycles by expanding existing car production in the Midlands.

Production of trucks and tractors is being moved from Birmingham and established as a new industry in Scotland. Domestic appliance production is being moved from Fisher and Ludlow Limited, of Birmingham, and centralised on Merseyside. In this way, besides helping the areas of high unemployment, the Corporation is freeing space in its present factories which, with some additional building in Birmingham, will make possible a considerable increase in car and light commercial vehicle production. It will, in fact, enable production to be expanded from the present capacity of 750,000 vehicles a year to 1,000,000 a year by 1962.

We are taking the slow-moving bulky jobs like trucks away from Birmingham and in their place will concentrate on smaller vehicles with a greater efficiency of production. For example, production of trucks (now about 1,000 a week) will be moved from the Austin factory to Scotland. The space freed at Longbridge will be used to expand production of power units for the Austin Seven and Morris Mini-Minor by 4,000 a week, as well as to produce other power units for cars. Mainly to provide for expansion of Austin Seven production, 350,000 sq. ft of new factory space will be built at Longbridge, and will include a new paint plant, and additional body and car assembly and trim facilities.

At Morris Motors (Tractor and Transmissions Branch) in Birmingham the removal of tractor production, together with some new building, will provide space for greatly increased production of transmission units for the small cars. At Fisher and Ludlow Limited, capacity freed by moving domestic appliances will be used to increase car-body production. Including extensions at S.U. Carburettors, there will be a total of nearly 600,000 sq. ft of new building by BMC in Birmingham.

We are, therefore, taking production of

60,000 vehicles a year (trucks and tractors) away from the Midlands, increasing our area in Birmingham by 600,000 sq. ft—and thereby increasing our car production here in the Midlands by 200,000 a year. The plan does not represent any expansion of the Corporation's labour force in the Midlands beyond the capacity of the present factories, and labour now engaged on work to be transferred will be fully absorbed by the increase in car and light commercial vehicle production in existing plants.

I mention these facts to put in perspective Mr. Novy's conclusion that " short of a miracle change either in the policy of our Government on industrial location or in car design—vehicle production in the Midlands will not increase greatly over the next decade." On the contrary, it is our aim that it *shall* increase greatly—not by Midland car factories extending over more virgin land (which is impossible), but by hiving off work not associated with car production and doing some new building strictly within existing factory boundaries.

Yours sincerely,
BRIAN TURNER,
Deputy Director of Publicity.

The British Motor Corporation,
Longbridge Works, Birmingham.

6 May, 1960.

Fatigue of Welded Structures

SIR, We were very pleased to see your report on the symposium recently held in Cambridge, entitled " Fatigue Criteria in Welded Structures " (ENGNG., 15 April '60, p. 512).

A small, but not unimportant, error occurs twice in this otherwise excellent report. Dr. W. Gilde and Mr. A. Neumann are both at the Zentral-institut für Schweisstechnik in the German Democratic Republic and not in West Germany as you state.

Yours faithfully,
P. H. R. LANE,
Head, Members' Service Department.

British Welding Research Association,
Abington Hall, Cambridge.

5 May, 1960.

Events in Advance

Manchester Electronics Exhibition and Convention

ARRANGEMENTS are being made by the Northern Division of the Institution of Electronics to hold their 15th Annual Electronics and Instruments Exhibition and Convention at the Manchester College of Science and Technology during the period 7 to 13 July next.

The exhibition will comprise a manufacturers' section and a scientific and industrial research section. Included in the first-mentioned section will be an extensive display of electronic devices and instruments, manufactured both in Britain and overseas, such as are likely to prove valuable in all sectors of scientific and industrial activity.

The second section will incorporate exhibits by the Admiralty and the Radio Research Station of the Department of Scientific and Industrial Research. Among other aspects of electronic endeavour in Britain, these displays will provide an indication of the work being accomplished in connection with earth satellites. There will also be demonstrations of a number of pieces of electronic apparatus. Lectures and film displays covering a wide range of electronic and instrument subjects are being organised.

A brochure entitled *Preview of the Exhibition and Convention* will be available from 10 June, price 6*d* postage paid, while the *Handbook of the Exhibition and Convention* will be available from 1 July, price 3*s* postage paid. Copies of these publications, complimentary admission tickets, and additional information relating to these events may be obtained from Mr. W. Birtwistle, general secretary, the Institution of Electronics, 78 Shaw Road, Rochdale, Lancashire, or by telephoning Rochdale 48759.

Exhibitions and Conferences

North Staffordshire Chamber of Commerce Golden Jubilee Industrial Exhibition.—Wed., 18 May, to Sat., 4 June, at Hanley Park, Stoke-on-Trent, Staffs. Apply to the secretary, North Staffordshire Chamber of Commerce, Commerce House, Shelton, Stoke-on-Trent. Tel. Stoke-on-Trent 21401.

Office Management, 41st International Conference and Exposition.—Sun., 22 May, to Thurs., 26 May, at Queen Elizabeth Hotel and the Show Mart, Montreal. Theme: " New Dimensions for Office Executives." Organised by the National Office Management Association (NOMA), Willow Grove, Pennsylvania, USA.

Combustion Problems, Open Discussion on.—Tues., 24 May (10.30 a.m. to 4.30 p.m.) at the Engineers' Club, Albert Square, Manchester. Organised by the North Western Region of the Combustion Engineering Association. Apply to the secretary, North Western Region, Combustion Engineering Association, c/o West's Gas Improvement Ltd., Albion Ironworks, Miles Platting, Manchester, 10.

Aerospace Vehicles, National Specialists' Meeting on Guidance for.—Wed., 25 May, to Fri., 27 May, at Somerset Hotel, 400 Commonwealth Avenue, Boston 15, USA. Organised by the Institute of Aeronautical Sciences, 2 East 64th Street, New York 21.

Commonwealth Exhibition and Commonwealth Weeks.—*Leicester:* Fri., 27 May, to Thurs., 9 June. *Tynemouth:* Fri., 24 June, to Thurs., 7 July. *Edinburgh:* Thurs., 25 Aug., to Sat., 10 Sept. Additional information obtainable from the chief press officers, Commonwealth Relations Office, Downing Street, London, SW1 (Tel. WHItehall 2323) and Colonial Office, Church House, Great Smith Street, London, SW1. Tel. ABBey 1266.

Powder Metallurgy Conference, International.—Mon., 13 June, to Wed., 15 June, at the Hotel Biltmore, New York City. Apply to Mr. Kempton H. Roll, Metal Powder Industries Federation, 60 East 42nd Street, New York 19.

British Computer Society, Second Annual Conference.—Mon., 4 July, to Thurs., 7 July, in the Sun Pavilion, Harrogate. Apply to Miss D. E. Pilling, Electronic Computing Laboratory, The University, Leeds 2.

Meetings and Papers

Association of Supervising Electrical Engineers

BRISTOL
" Waterworks Installations": Discussion. Bristol and West of England Branch. Grand Hotel, Bristol. Mon., 16 May, 8 p.m.

FARNBOROUGH
" High-Voltage Porcelain Insulators ": Discussion. Aldershot Branch. Queen's Hotel, South Farnborough, Hants. Tues., 17 May, 7.45 p.m.

Combustion Engineering Association

BIRMINGHAM
" The Automatic Boiler House," by M. A. Beechly. Midland Region. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Thurs., 19 May, 10.15 a.m.

Institute of Fuel

LONDON
" Recommendations on Heights for New Industrial Chimneys," by G. Nonhebel. Institution of Civil Engineers, Great George Street, SW1. Mon., 23 May, 5.30 p.m.*

Institution of Civil Engineers

LONDON
" Port of London Authority: Developments of Two Dock Areas, 1959," by D. E. Glover, E. Newton, H. M. Dale and T. R. Brown. Tues., 17 May, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Annual General Meeting and Film Display. London Graduate and Student Section. Mon., 16 May, 6.30 p.m.*
" Technical Features of a New Television Studio at Wembley," by Dr. A. M. Spooner, at 6.30 p.m. Annual General Meeting. Thurs., 19 May, 5.30 p.m.*
Education Discussion Circle Meeting. Fri., 20 May, 6 p.m.*
" New Semiconductor Devices and Their Possible Applications": Discussion, to be opened by Dr. A. F. Gibson and G. King. Electronics and Communications Section. Wed., 25 May, 5.30 p.m.*

SHEFFIELD
" The Design of Housing-Estate Distribution Systems Using a Digital Computer," by Dr. R. L. Grimsdale and P. H. Sinclare. Annual General Meeting. Sheffield Subcentre. Grand Hotel, Sheffield. Wed., 18 May, 6.30 p.m.

STAFFORD
" The Characteristics and Protection of Semiconductor Rectifiers," by D. B. Corbyn and N. L. Potter. Annual General Meeting. North Staffordshire Subcentre. Technical College, Stafford. Mon., 16 May, 7 p.m.*

Institution of Mechanical Engineers

LONDON
" The Automobile of the Far Future," by A. A. Kucher. Automobile Division. Wed., 18 May, 6 p.m.*
" Mechanical Aspects of Fractional-Horse-Power Motors," by P. G. Edkins. Annual General Meeting. London Graduates' Section. Tues., 24 May, 6.30 p.m.*

Institution of Mining and Metallurgy

LONDON
Annual General Meeting, at 4 p.m. Tea, at 4.30 p.m. Presidential Address on " Progress in Mining Geology; Education, Research and Employment," by Professor David Williams, at 5.15 p.m. Geological Society, Burlington House, Piccadilly, W1. Thurs., 19 May.

Institution of Plant Engineers

LONDON
" Factory Safety ": Discussion. Royal Society of Arts, John Adam Street, Adelphi, WC2. Wed., 18 May, 7 p.m.*

BLACKBURN
" Some Medium-Sized Boiler Houses," by G. A. Rooley. Blackburn Branch. Castle Hotel, Blackburn. Thurs., 19 May, 7.30 p.m.

CARDIFF
" Controlled Maintenance," by G. E. Halter. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 24 May, 7.30 p.m.

ROCHESTER
" Use of Liquid Petroleum Gas," by A. G. Turner. Kent Branch. King's Head Hotel, High Street, Rochester. Wed., 18 May, 7 p.m.

Royal Aeronautical Society

LONDON
" My First Ten Years," by Sir Thomas Sopwith. Inaugural Lecture. Historical Group. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 17 May, 6 p.m.*
" Mathematics and Aeronautics," by M. J. Lighthill. 48th Wilbur Wright Memorial Lecture. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 19 May, 6 p.m.*

Royal Institution

LONDON
" Luminescence: The Cold Light of Physics," by Professor G. F. J. Garlick. Wed., 25 May, 9 p.m.

Royal Institution of Naval Architects

LONDON
" Warships, 1860 to 1960," by A. J. Sims; and " Merchant Ships, 1860 to 1960," by J. M. Murray. Centenary Meeting. Festival Hall, South Bank, SE1. Tues., 17 May, 2.30 p.m.

Royal Meteorological Society

LONDON
" Summer Circulation of the Arctic Stratosphere below 30 km," by F. K. Hare; " An Experimental System for Directly Recording Statistics of the Intensity of Atmospheric Turbulence," by J. I. P. Jones and F. Pasquill; and " The Reflection of Short-Wave Radiation by Vegetation," by J. L. Monteith. Wed., 18 May, 5 p.m.*

Royal Society

LONDON
Various short papers. Thurs., 19 May, 4.30 p.m.*

Royal Society of Arts

LONDON
" Transmission of Power," by F. H. S. Brown. Second of three Cantor lectures on " Energy," Mon., 16 May, 6 p.m.*

Royal Statistical Society

LONDON
" Decision Making in the Steel Industry," by Dr. K. D. Tocher and A. Muir. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 25 May, 5.15 p.m.*

Society of Instrument Technology

LONDON
Annual General Meeting, at 6 p.m. Presidential Address, at 7 p.m. Manson House, 26 Portland Place, W1. Tues., 24 May.

NEWCASTLE UPON TYNE
Annual General Meeting. Newcastle Section. Roadway House, Oxford Street, Newcastle upon Tyne. Wed., 18 May, 7 p.m.

South Wales Institute of Engineers

CARDIFF
" Aberthaw Power Station," by W. Wilde. Thurs., 19 May, 6 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. (KENsington 0730)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)

Mechanical Handling Exhibition London, 3-13 May

MECHANICAL handling has made possible many processes and operations that could not otherwise have been used on account of either the danger or the high cost of human labour.

The recent exhibition at Earl's Court, opened by the Rt. Hon. Reginald Maudling, President of the Board of Trade, on 3 May, brought together a respresentative collection of equipment. Controls were prominent, showing how automatic systems are becoming more and more used, even in industries that do not seem to lend themselves to electronics, as, for instance, in shopping. The Solartron-John Brown supermarket is an example. There is no picking up of goods by the customer: a card inserted in a slot is printed with the goods needed, then handed to the cashier who places it in another slot. In 15 seconds, the whole of the purchases are mechanically delivered to one of the booths, ready for putting in the basket. There is thus no manhandling of goods either by the customer or the shop assistant. After this, tractors that do no more than automatically follow painted lines or buried cables seem commonplace.

STACKER

Hand Or Power

A NEWCOMER to the range of stacking trucks is the Mastiff, available in both power and manual versions.

One of the claims for this truck is that it has been tailored to suit the human body. The power version illustrated is driven by a battery which will give 110 lifts of the full load of 750 lb. Control of both lift and lower is by push button. A larger version will take 1,100 lb.

The maximum lift is 5 ft and the overall height is 79½ in. The width overall is 27 in and across the forks 16 in. The overall length is 39½ in. Lift speed is 18 ft per minute. The frame is all steel welded construction with front and side plates to protect the mechanism. Braking is by pressure pads applied to the floor by a direct action cam, operated by a hand lever. The truck is mounted on smooth running castors, 6 in diameter at the rear and 4 in diameter at the front.

The hand operated version follows the same general specification but the

lift mechanism is driven from a two-speed double action hydraulic pump housed in a light alloy casting at the foot of the mast. Assuming one stroke per second the normal setting gives a lift of 5 ft in 85 seconds for a force on the handle of 18 lb. *J. E. Shay Limited, Kingsclere Road, Basingstoke, Hampshire.*

MOBILE CRANE

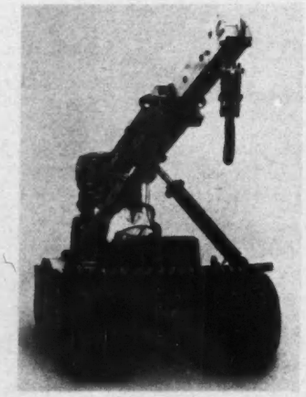
Hydraulic Operation

A MOBILE crane with both the slewing and luffing actions operated by the same hydraulic cylinders is the Iron Fairy VI.

The jib of the crane is pivoted on the rear of the chassis and rests on two hydraulic cylinders towards the front. Extending both these cylinders together lifts the jib in a straight line; extending them unequally causes the slewing action. An angle of 45° can be covered by slewing. At lowest the jib lies horizontal giving an overall height of 8 ft 11 in. The maximum lift is 22 ft. The overall width is 7 ft 9 in.

There are two stages of jib extension; the first is under hydraulic power and gives a movement of 8 ft and the second is manually operated and gives another 4 ft. The maximum ahead reach of the hook is therefore 16 ft from the front of the front wheel. At a radius of 5 ft the permissible load is 1,344 lb and at 18 ft from the front axle, 3,020 lb.

Power is supplied by a Newage/BMC 6-cylinder engine which drives to the



front axle through a clutch and four speed gearbox. Road speeds are up to 18 m.p.h. Towing lugs are provided. Kirkstall cam air brakes operate on all four wheels. Steering of the rear axle is power assisted. *British Hoist and Crane Company Limited, Compton, Berkshire.*

CHARGER

For Traction Batteries

NOW being made for traction batteries is a range of chargers using germanium rectifiers.

The units are designed to meet the requirements of BS2550 and can be for either taper or two-stage operation. Mains electricity from a single phase supply is fed to a vacuum impregnated transformer with six primary tappings to allow for mains variation. The transformer is double wound with an earth screen and is conservatively rated.

Germanium rectifiers are used for their characteristics and reliability. Protection on the incoming side is provided by a high speed circuit breaker and on the d.c. side by a high speed fuse. The charge is terminated in both the taper and two stage types by an MJV relay which is also used in the two stage model to operate the contactor for changing the charging rate.

The cubicle framework is extruded aluminium and the panels of sheet metal. All controls are recessed to prevent damage. Regulation and termination of

the charge are both automatic; all that is necessary is to plug in, reset the relay and switch on. The frame structure carries all the weight of the components directly on the back support as well as the clamp for the connecting cable. *Oldham and Son Limited, Denton, Manchester.*

ELECTRIC FORK TRUCK

High Speed Operation

THE Rapide is an electric fork truck that will operate at speeds comparable to those of the engine driven types.

The first two models have capacities of 2,000 and 3,000 lb and ground speeds of 12 to 14 m.p.h. They can mount gradients up to 1 in 5. To conserve the battery at the lower speeds, up to 7 m.p.h., they operate at 24V; it is only for the higher speeds that the full battery is brought into action to give a 48V supply. With a 2,000 lb load the lift speed is 50 ft per minute and for 3,000 lb 33 ft per minute.

The series wound motor is coupled directly to the front axle which has a double reduction differential unit. A 16 in diameter steering wheel operates through a recirculating ball type box and is linked to the axle by drag links. The turning radius is 5 ft 7 in. The truck itself is 40 in wide and can work in aisles 10 ft wide. The twin telescopic mast gives a lift of 10 ft and can be tilted back through 10° and forward 3°.

The chassis is electrically welded steel with a low centre of gravity to make the truck stable. Braking is rheostatic when the foot is lifted from the accelerator pedal, and hydraulic from a brake pedal. There is also a hand brake for parking. *Lansing Bagnall Limited, Kingsclere Road, Basingstoke, Hampshire.*

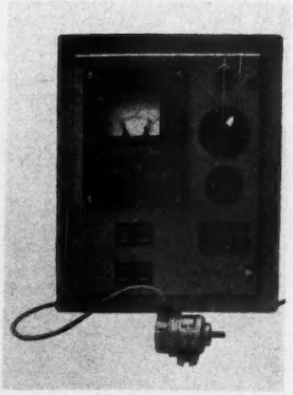
SPEED CORRECTOR

For Winding Drums

A SPEED corrector unit has been introduced for use with the Kopp Variator variable speed controls.

The equipment is controlled by a voltage signal from an alternator which is driven from the output of the power unit. The particular design shown is for maintaining the linear speed of material being wound on a drum at a constant figure, and therefore the alternator is driven from the material itself. The signal is fed to the control panel and is used to adjust the position of the Variator unit in the drum drive.

The unit is fully automatic in operation and will work over the full range of the Variator control. It is suitable for all size models. The required speed is set on a dial and is maintained correct to within 1 per cent or 5 per cent according to the demands of the process. Provision can also be made for an overriding switch to give manual control and inching stations for presetting purposes so that speeds for different materials and processes can be found.



Alternative models can be supplied for wall and panel mounting as required. All external wiring is made to terminal blocks inside the speed corrector panel. The speed error at any time is shown on the meter mounted on the panel. *Allspeeds Limited, Clayton-le-Moors, PO Box 43, Accrington, Lancashire.*

German Industries Fair Hanover 1960

THE 1960 trade fair at Hanover closed on 3 May, after its 10 day run. Attendances were well up on last year, but the final figures are not yet available. Bookings are now being made for 1961, although some firms have rental agreements extending over 10 or 12 years. Some of the items on show were described in our issue of 6 May and some more are given here.

AIR COOLED DIESEL ENGINES

THREE new diesel engines have been added to the Lister ranges.

The LD/SL range has been increased by the addition of a four-cylinder model developing 17 b.h.p. at 1,800 r.p.m. Bore and stroke are $3\frac{7}{16}$ in by $3\frac{1}{2}$ in and the fuel consumption at full load is given as 0·53 lb per b.h.p. hour. The weight of the bare engine is 530 lb.

The other two engines are added to the HA/HB range. They are four and six cylinder models of 4 in bore and $4\frac{1}{2}$ in stroke. The HB6 engine develops a maximum of 102 h.p. at 2,000 r.p.m. and the HB4 model 63 h.p. at 2,000 r.p.m. Outputs of the HA4 and HA6 are 44 and 66 h.p. at 1,800 r.p.m. Weights of the bare engines are 880 lb and 1,200 lb. *R. A. Lister and Company Limited, Dursley, Gloucestershire.*

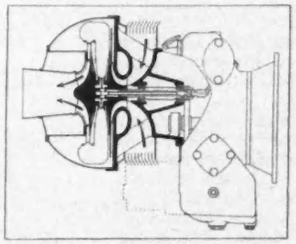
SMALL GAS TURBINE

65 h.p. Rating

THE BMW6002 gas turbine has a rated output of 65 h.p. at 45,000 r.p.m. for a dry weight, including gearbox, of 145 lb.

The unit operates on the open cycle principle without a heat exchanger. Turbine and compressor are mounted back to back on a shaft overhung from the main bearings. Between them in the annular space is the combustion chamber. Power is taken off from the free end of the shaft.

Fuel is injected centrifugally into the chamber through drilled passages in the injection wheel which is part of the rotor assembly. Thus all nozzles are eliminated. Air enters through a protective grid, which also acts as a silencer, and is compressed into the combustion chamber. Part is mixed and burnt in the primary zone and the rest is used to cool the walls of the chamber and then is mixed with the burnt gases to cool them before they reach the turbine wheel. This is to give a longer life to the blading.



The exhaust is through a straight diffuser or can be deflected through an elbow.

Turbine and compressor with the injector wheel between them are held by a tension rod against a bearing shoulder on the shaft. The combustion chamber consists of two circumferentially closed ring shells, with ring glands opposite the injection wheel. The main casing is light alloy. A pinion on the free end of the rotor shaft drives the output through a double gear train; ratios available give between 3,000 and 11,000 r.p.m. for the output. Most fuels can be used and the unit can be hand or power started. *BMW Triebwerkbau GmbH, Dachauer Strasse 665, München-Allach, Germany.*

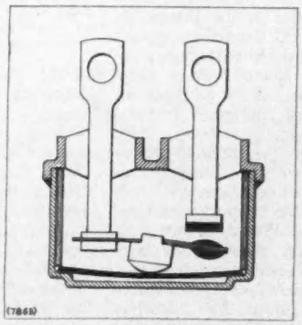
THERMOSTATS

Snap Action Discs

KLIXON thermostats are hermetically sealed units of which the operating element is a Spencer disc.

This disc is dished in shape and operates by reversing its curvature according to temperature. In the position shown, the contracts are open; a rise in temperature causes the disc to snap over to the opposite curvature and so close the contacts. By reversing the disc initially, the reverse action can be obtained. An alternative form is available which is more suitable for applications when the greatest vibration is to be expected with the contacts in the open position; this has the moving arm operating upwards. Again, either normally open or normally closed contacts can be had.

The units are hermetically sealed with the contact terminal posts passing through fused glass in the cap, which is soldered to the body. An insulating lining is fitted. The body is $\frac{1}{8}$ in diameter and the weight without mountings is 0·2 oz. Several forms of mounting are available. There are five models



for operating in temperatures from −65° F to +400° F. Temperature setting tolerances can be as small as 5° F on both the opening and closing settings. The silicone rubber overmould, when used, has a temperature tolerance from −65° F to +450° F. Electrical ratings are up to 7A (resistive), according to voltage and frequency. *Metals and Controls Corporation, Spencer Thermostat Division, Attleboro, Massachusetts, USA.*

THERMOMETER

With Many Attachments

THE AAP Tastotherm is an electronic thermometer that by the combination of a number of basic units can give 275 different models.

Special claims for the instrument are that it gives instant indication; has a mirror scale for accuracy; can measure surface or internal temperatures; and does not use amplifiers that require resetting. The basic unit is illustrated and to this are added the various power supply units to suit local mains, and the probe chosen to suit the working conditions.

A thermistor is used as the sensing element and operates in conjunction with a bridge circuit fed from a dry cell. The bridge scale is direct reading. Accuracy is within 2 per cent of full scale deflection on any of the ranges, and these cover from − 30 to + 220° C in the standard equipment. Versions to measure over the range from − 80 to + 400° C can be supplied to order, as can scales to Centigrade or Fahrenheit units. The case measures 210 mm long and 124 mm wide

at the widest point; it is 90 mm to the highest point. The weight it 1,000 gm (approx. 2·2 lb) and a carrying case is available.

The temperature range is covered by six scales, with divisions ranging from 0·2 to 2·5° according to coverage. The probes include models for surface or internal measurement and with straight or angled tips. All plug directly into the main unit. *AAP-Allgemeiner Apparatebau GmbH and Co., Tullastrasse 70, Freiburg im Breisgau, Germany.*

PORTABLE GAS TURBINE

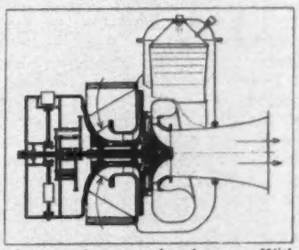
Low Temperature Starting

ONE of the points put forward for the T 16 small gas turbine is that it will start at temperatures down to − 40° C.

The turbine has a rating of 80 h.p. at 50,000 r.p.m. and can be fitted with a gearbox as shown to reduce the speed to 4,300 r.p.m. It operates on the open cycle principle.

Turbine wheel and compressor are mounted back to back on the main shaft and overhang the main bearings. A seal is fitted between them. Air enters radially through a screen and is compressed into the combustion chamber. Fuel is injected into the head of the chamber and the burnt gases pass along a volute to the turbine wheel. Discharge is straight. Air from the compressor circulates over the outside of the volute and the combustion chamber. Ignition is by glow plug and friction igniter.

The reduction gearbox is fitted in line. The output shaft has a bevel drive to the governor, the fuel pump and the oil pump. The drive from the starter is



taken to the same bevel gear. With gearbox, governor and pumps the dry weight is 63 kg (139 lb); in working order the fire fighting unit weighs 140 kg. (308 lb).

Turbine and gearbox measure 750 mm long and 500 mm wide; height to the top of the combustion chamber is 625 mm. The unit will run satisfactorily even when tilted to an angle of 30°. Its light weight, lack of maintenance and instant starting make it an excellent standby unit. Suggested applications include pumps and compressors and, mounted with the shaft vertical, as the drive for an outboard motor. *Klöckner-Humboldt-Deutz AG Köln, Germany.*

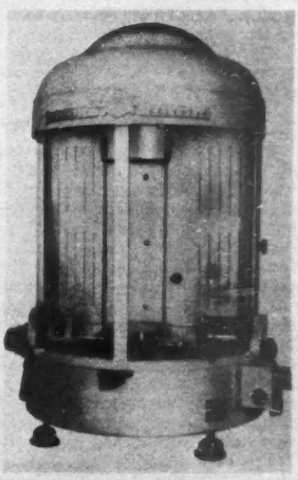
ANALYTICAL BALANCE

High Speed Operation

THE analytical balance illustrated is a high speed instrument reading to an accuracy of 0·01 mgm.

Three main features of the instrument are the fully autoplacing of the weights; fully mechanical subdivision; and the effective viscous damping using air. The weighing of a sample can be carried out in 15 seconds.

The position of the mechanical switches and the stops allow the operator to assume an easy working position and it is claimed that the scales are particularly easy to read. A projected Vernier scale provides the final figure. The maximum weight that can be handled on the Semi-Mikro is 100 gm (200 gm on the others), and the scale pan is 90 mm in diameter. There is 185 mm clearance above the pan. The Ultra has magnetic damping whereas the standard and the Semi-Mikro rely on air. Models are available for remote control; for use with acidic materials; and with automatic recorders. To ensure freedom from damage during operation an automatic



arrangement is included to lock the balance while the weights are being changed. *Sartorius-Werke AG, Göttingen, Germany.*

Italian Cars Styled For European Market

Led by Fiat, the Italian motor industry is well adapted to the European Common Market. Production facilities, styling and technical features show an awareness of export requirements.

By Richard Bailey

LAST year the Italian motor industry turned out 500,769 vehicles, of which 470,650 were passenger cars. But the important fact about the Italian motor industry is not that it is smaller than those of Britain, Germany and France, but that it is geared for expansion and is very export minded. The relative outputs of the major European car manufacturers is shown in Table I.

Nearly 90 per cent of Italy's car production comes from Fiat of Turin. For many years the Italian tariff of 45 per cent on imported cars has given Fiat a virtual monopoly of the Italian market. This rate was cut to 40 per cent in the first round of tariff cuts designed to bring about the European Common Market of the Six on 1 January, 1959. This particular cut was extended to Britain and other members of the GATT. The next cut, due on 1 July next, will bring the Italian tariff down to 36 per cent. The eventual level for motor cars entering the European Common Market will be 29 per cent.

These figures help to explain the unique position of Fiat among the motor car producers of Europe. The Common Market will bring foreign competition for the first time into Italy itself. And this at the moment when Fiat's great rivals Volkswagen and Renault will both be stepping up their endeavours to increase their share of the European and overseas markets. This situation calls for action both on the production and marketing fronts.

The production challenge is being met by concentrating on the type of car for which demand is highest. Over 60 per cent of last year's output consisted of small utility cars of 500 or 600 c.c. But unlike Volkswagen, which turns out variations on a basic theme, Fiat produces a range of cars right up to a 1,795 c.c. six-cylinder model, which competes with the Alfa Romeo. A list of Fiat models is given.

Fiat's star model at the present time is the Fiat 600. This is a 633 c.c. rear-engine car, which appears in various versions as 4-seater saloon, convertible and the utility "Multipla." One version is widely used as a taxi in Milan and other Italian cities. The second favourite is the smaller Fiat 500, a two-cylinder rear engine car which has evolved steadily over the past ten years. Like Renault, Fiat is now concentrating on the larger of its two small cars, although the "600" has a long way to go yet before it gets as far in front of the "500" as the "Dauphine' is ahead of the Renault 2 c.v.

MAKE THEIR OWN COMPONENTS

At the main Fiat plant, the Mirafiori works at Turin, there are some 19,000 workers plus some 2,500 office staff. The production floor is organised so that the whole output is on one level. Outside, a group of buildings house the open-hearth steel melting furnaces, electric arc furnaces and rolling mills. The latter have post-war American equipment bought partly with Marshall Aid funds. Much of the steel sheet used at Fiat is rolled from coils supplied by Cornigliano, the State-owned steelworks at Genoa, which has Italy's only wide strip mill. But apart from supplying sheet steel for its own manufacturing needs the Fiat Ferriere rolling mills turn out bars, shapes, hoop iron, wire, tubes, springs and other products.

The Fiat assembly lines are now turning out about 1,600 cars a day by production methods that are as modern as any to be seen anywhere else in Europe. A distinctive feature of the Fiat organisation is that it makes the greater part of the components itself. Exceptions are tyres, electrical equipment manufactured by Magneti-Marelli, a subsidiary company, and ball bearings made at the Riv factory. Outside the Mirafiori factory is the much photographed figure-eight test track, on which cars taken straight from the production lines are put through their paces. Fiat's older Lingotto factory, also in Turin, used to be famous for its roof-top testing track. This is now used for new models only.

Apart from motor cars, Fiat makes tractors, heavy lorries, both Fiat and OM (Offici Meccanice) buses, tramcars, railway rolling stock and diesel locomotives, large marine engines and aircraft. There is also a machine-tool section which manufactures various automatic and transfer machines under licence. In quite a different field are the refrigerators, washing machines and other consumer durable that Fiat makes under American licence.

TABLE I.—*European Car Production*

Country	*Number of vehicles*	*Number of cars*
Italy	500,769	470,659
Germany	1,718,566	1,503,424
United Kingdom ..	1,560,427	1,189,943
France	1,283,159	1,127,982

Source: National Federation of the Motor Industry

The second biggest Italian motor manufacturer, Alfa-Romeo, is part of Finmeccanica group of IRI, the body responsible for State participation in industry. Although producers of a famous high-quality car, Alfa-Romeo is on too small a scale to be a factor in foreign competition for some time to come. The annual production is of the order of 17,000 cars. The only other make of any consequence is Lancia, which also has its factories in Turin. Lancia made under 9,000 cars in 1958, but production of the successful "Appia" model has been increasing steadily and is expected to top 10,000 this year. Control of Lancia was taken over a few years ago by Signor Pesenti, a business man new to motor cars but with a big name as an organiser and revitaliser of fading concerns. The capital structure of the firm has now been completely reorganised. Fresh capital has been raised and it looks as though Lancia may be back among the big names of motoring.

BODY STYLING

Apart from the efficiency of their manufacturing methods, which are not in any case outstandingly better than those in the British or the big continental companies, the Italian motor-car firms have one considerable advantage over their rivals. This is the great skill of their coachwork designers which has set its mark on the cars of all the other European makers. Pinin Farina's name is the best known here because of his work for the British Motor Corporation. But there are also Ghia, Boano Michelotti, and Touring, all of whom are internationally famous. In the export markets, including those of the New World, design is an extremely important factor, although the continued sales successes of Volkswagen prove that it is not the only one. However, in launching new models there is no doubt that attractive design following what is regarded as the smart line at the moment is vitally important.

The export challenge is one that the Italians have been quick to take up. Fiat have four ships specially fitted out to carry 1,000 cars each from Genoa to the United States. There the Fiat small cars, the "500" and "600" have been gaining ground steadily. In 1958 Italy sold 30,759 cars there, and pushed this figure up to 48,194 last year, of which Fiat accounted for 38,451. In Europe, Fiat's best customer is Germany, which took 69,281 cars in 1958. To some extent this success is a reflection of the success of the Volkswagen export drive. With a long waiting list for Volkswagen at home the Germans have been buying the readily available Fiat 600 instead. Fiat is now the third most popular car in Germany, following Volkswagen and Opel. Farther afield, Italian, which means preominantly Fiat, exports have been rising steadily. South America, India, Australia and Canada are becoming important markets.

What will be the effect of the opening of the European Common Market on the Italian motor-car industry? The details of present tariffs, and of the forthcoming cuts, were given at the beginning of this article. On the whole the Italians are confident that they can stand up to increased competition, but they point out some of the special difficulties facing them. One is the Italian taxation system, which takes a toll on every stage in manufacturing at which anything that can be identified as a definite product is produced. As a result, the Italian car pays its taxes before being exported and then pays import duties, purchase tax, and the like, on entering the importing country. Another factor that is not generally recognised abroad is the high cost of skilled labour in Italy. Although Italy has a higher rate of unemployment than any other European country, the level of wage rates for skilled labour is high. In addition the big firms like Fiat, Olivetti, Montecatini, themselves make up the deficiencies in the Italian welfare services. Fiat, for example, lays on such extras for its workers as kindergartens, sanatoria, training schemes, convalescent homes, medical services, sports clubs, houses and flats and, finally, funeral arrangements.

TABLE II.—*List of Current Fiat Models*

FIAT 500
Rear-mounted 2-cylinder engine—Displacement 479 c.c.—Output 16·5 h.p. (SAE rating 21 h.p.)—Gearbox with 4 speeds and reverse—Top speed about 60 m.p.h. (95 km per hour).
Sports version: Rear-mounted 2-cylinder engine—Displacement 499 c.c.—Output 21 h.p. (SAE rating 25 h.p.)—Gearbox with 4 speeds and reverse—Speed over 65 m.p.h. (105 km per hour).

FIAT 600
Rear-mounted 4-cylinder engine—Displacement 633 c.c.—Output 24·5 h.p. (SAE rating 28·5 h.p.)—4 speed gearbox with reverse—Speed: Sedan and Convertible about 62 m.p.h. (100 km per hour); Multipla about 60 m.p.h. (95 km per hour).

FIAT 1100
4-cylinder engine—Displacement 1,089 c.c.—Output 43 h.p. (SAE rating 48 h.p.)—Gearbox with speeds and reverse—Speed 75 m.p.h. (over 120 km per hour).
De Luxe version: 4-cylinder engine—Displacement 1,089 c.c.—Output 50 h.p. (SAE rating 55 h.p.)—4-speed and reverse gearbox—Speed about 80 m.p.h. (130 km per hour).

FIAT 1200
4-cylinder engine—Displacement 1,221 c.c.—Output 58 h.p. (SAE rating 63 h.p.)—Gearbox with 4 speeds and reverse—Speed: full-light about 87 m.p.h. (140 km per hour); Cabriolet about 90 m.p.h. (145 km per hour).

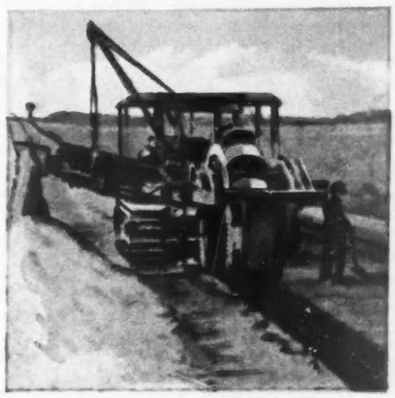
FIAT 1500
4-cylinder engine—Displacement 1,491 c.c.—Output 80 h.p. (SAE rating 90 h.p.)—Gearbox with 4 speeds and reverse—Speed about 105 m.p.h. (170 km per hour).

FIAT 1800
Straight 6-cylinder engine—Displacement 1,795 c.c.—Output 75 h.p. (SAE rating 85 h.p.)—Displacement 2,054 c.c.—Output 82 h.p. (SAE rating 85 h.p.)—Gearbox with 4 fully synchronised gears and reverse—Speed: Sedan over 87 to about 93 m.p.h. (140-150 km per hour) according to displacement; Station wagon about 87 to about 90 m.p.h. (140-146 km per hour) according to displacement.

FIAT 2100
Special model of "1800."

But although they are very ready to point out the difficulties of the situation, the Italians are not unduly worried. The arrangement under which Alfa-Romeo is to assemble Dauphines in Italy, for example, is not yet in full production. And even then, it is doubtful if it will do very much to change the all-Fiat look of Italian car parks for a considerable time. In any case, with rising prosperity, the Italian home market for cars is expanding almost as rapidly as the British and German. With increasing demand at home, and a good sales organisation abroad, the Italian motor-car industry should have little trouble in taking the next step into the European Common Market.

S & L STEEL PIPES
FOR
SOUTHERN GAS BOARD'S INTEGRATION MAIN

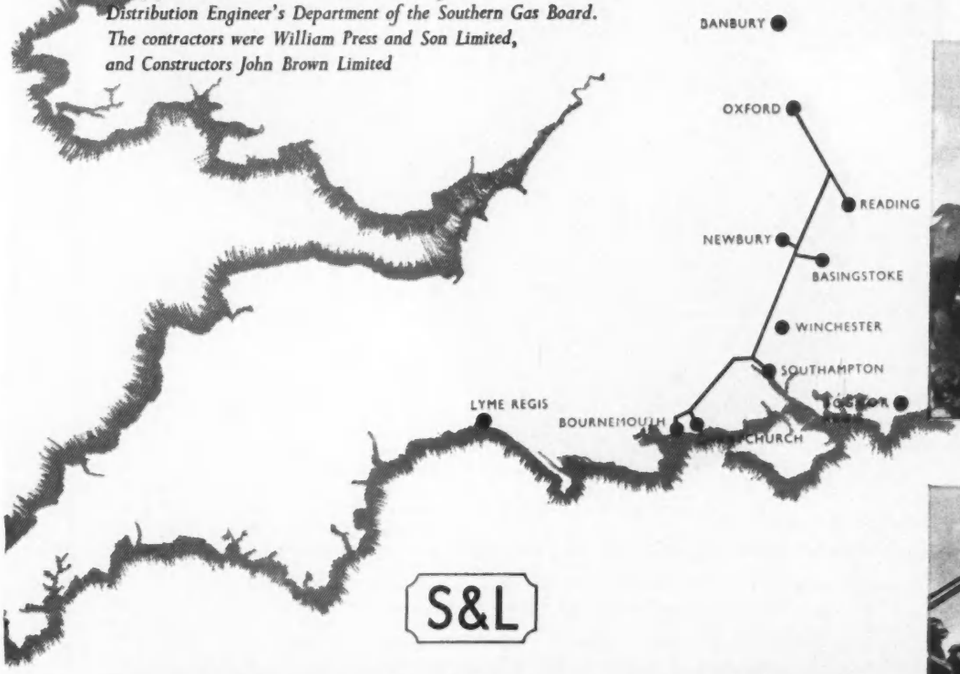


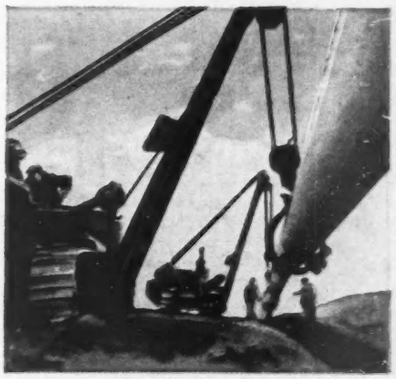
S & L have supplied over 130 miles of steel pipes—the major part 16 inch outside diameter—for this high pressure integration main which is one of Britain's longest underground pipelines.

This pipeline, linking main centres of production, supplies a large area extending to Lyme Regis and Bognor Regis in the south, and northwards beyond Banbury. The pipes, painted internally with red lead, are protected externally against corrosion with Stewarts and Lloyds' woven glass reinforced sheathing, which also affords ample protection during transit and handling at site. Stringent tests were applied both to pipes and sheathing.

Rapid progress was made in laying this important main. Pipes with bevelled ends were welded together above ground over distances up to two miles and 'snaked' into trenches as illustrated.
The whole scheme was completed well ahead of schedule.

The pipeline was laid under the direction of the Distribution Engineer's Department of the Southern Gas Board. The contractors were William Press and Son Limited, and Constructors John Brown Limited





S&L

STEWARTS AND LLOYDS LIMITED

Glasgow · Birmingham · London

COCKBURN-
ROCKWELL
BUTTERFLY
VALVES

Rockwell designed, Cockburn engineered—a combination that provides valves superior to any on the European market. Cockburn-Rockwell Butterfly valves ensure precise throttling and positive shut-off regardless of the pressure, temperature and nature of the fluid or gas. Direct or remote control can be provided with manual, pneumatic, hydraulic or electric operators. Cockburn-Rockwell valves are made in all standard sizes up to 132″ in any metal; they can be rubber lined to resist corrosion or stress-sealed for extreme temperature variations.

COCKBURNS LTD Cardonald Glasgow SW1

Human Element

Birfield Industries' Scholarship Awards

THE three successful applicants who benefit from the Birfield university scholarship scheme have been announced.

Their schools were Oundle, Eton and King Edward's School, Norwich. The effect of the scheme is that the three young men will read mechanical engineering in three year courses at residential universities, all the costs being met by Birfield and with salaries of about £350 a year. They will then follow through with a two-year apprenticeship (salary in training between £550 and £700 a year) and go on to a staff appointment in the widespread Birfield group. This post will be one acceptable to the professional institutions as "a position of responsibility."

The Birfield group expresses the hope that its scholars, having become chartered engineers, will go on to find the interest they want from their careers and also senior managerial or technical positions—within the group.

Since the Birfield group embraces the railway, automotive, aircraft, agricultural, filtration and general engineering industries, the chances of the chartered engineer finding fulfillment would seem to be high. The research, training and information facilities of the group's twenty companies are pooled for greater strength and economy but trading competition is preserved.

Applications for consideration for a Birfield scholarship are accepted from boys whose qualifications admit them to an honours degree engineering course and who are seeking a place at a university.

Apprentices' Springtime Frolic

In the spring the young man's fancy . . ' but unfortunately the 35,000 striking apprentices in Scotland turned instead to industrial activities, or to ceasing them. Any experienced trade-union leader knows that the state of the weather has its influence on the course of a strike, and apprentices, who presumably have no wives to harrass them, enjoy walking around in the sun as well as anybody.

The Shipbuilding Employers' Federation has nailed the strikers' claim that they have had no wage increase for six years. The figures they gave show that the first-year apprentice has had an increase of 20*s* a week in the last eight years and the fifth-year apprentice one of 39*s*.

The exact figures are shown at the bottom of the page.

And these figures give grounds for thought. Certainly the apprentice is learning, he will reap the benefits for the rest of his working life, but he is of some present use to his firm and he is also human. When boys who are in no way becoming skilled, and whose contribution to the company's efforts appears no greater, are earning at least twice as much as the apprentices the effect cannot but be unsettling. That is not good either for undisturbed training or for loyalty.

And some sharp tests of loyalty have been going on beneath the surface of the apprentices' demonstrations.

In many works the engineering apprentices who will eventually become qualified, and who stand in a special relationship to their company, have come out along with their craft colleagues. It may be that among the former there are more whose interest is in the job rather than what they can get out of it. However that may be, there are firms where the engineering apprentices have stayed at work.

The general experience is that the overseas student apprentice, brought to the United Kingdom under one scholarship scheme or another, has stayed with the firm.

The strike is heavily frowned upon by the Amalgamated Engineering Union, who would like to see the boys get back inside the gates so that their leaders can get on with negotiating a pay rise. The shipbuilding employers have now told the Confederation of Shipbuilding and Engineering Unions that they cannot discuss the claim with them until the boys do return to work.

As the unions say on every suitable occasion, 99 per cent of British shop stewards are reasonable chaps more interested in keeping the peace than in marches and walkouts. In this strike there have been many occasions where the shop stewards have told the boys not to be misled and to get on with the job.

There have even been some cases where the boys have done just that.

Uproar, Recrimination and a Wage Demand

Few of the annual conferences of the Amalgamated Engineering Union's national committee can have had so much importance for the engineering industries.

The fury of the attack made by Mr. W. J. Carron, the president, upon unofficial action taken by shop stewards, often politically motivated, was not that of a man in full cry after a retreating enemy. It was much more that of a leader who knows that the battle with the elements, who would destroy all hope of moderate leadership if they succeeded, is not one in which the end can be predicted.

Mr. Carron is himself a product of the successful struggle to prevent Communist control of union leadership, a phase of the post-war trade union story that has given way to concentration of a variety of Stalinists, Trotskyists and just plain Marxists on efforts to run local union affairs.

The AEU president spoke strongly against the Engineering and Allied Trades National Council of Shop Stewards, whose recent abandonment of a strike threat suggests that their own view of their influence is more pessimistic than that gained from listening to Mr. Carron. He insisted upon democratic elections free from falsification and intimidation.

It is an indication of the intensity of the struggle that after his speech Mr. Carron was fiercely attacked by men who sit with him on the national committee at the head of the union's affairs.

As expected, the national committee approved, unanimously as it turned out, the motion for a wage increase of £1 a week. If this finally reaches the employers towards the turn of the year and is in a final stage of negotiation early in 1961 it could be that increased productivity will have gone some way towards meeting its effects. It would be impossible to see its effects as anything more than adding to the inflationary consequences of the shorter basic working week before that time.

Year of Apprenticeship	*April, 1960*	*April, 1954*	*May, 1952*
First	63*s* 1½*d*	49*s* 2*d*	43*s* 10*d*
Second	74*s* 10*d*	57*s* 5*d*	50*s* 9*d*
Third	96*s* 7*d*	75*s* 8*d*	67*s* 8*d*
Fourth	113*s* 4*d*	88*s* 11*d*	79*s* 7*d*
Fifth	130*s* 0½*d*	102*s* 2*d*	91*s* 6*d*

The Office Boy an Occupational Risk ?

The New York State court which recently held that shooting paper clips with a rubber band by an office boy was reasonably to be associated with his job was stating legally what we already suspected.

Boys will be boys is a shorter way of putting it. But, said the court, if boys, recognisably troubled by youth and restlessness, are employed in offices, considerable "latitude and freedom" must be used in judging what is within the course of their employment.

The State court refused to set aside a workmen's compensation award to a James Johnston, who, at any rate in 1955, was a youthful office boy, for injury to one of his eyes when he had a mishap firing paper clips.

No doubt the employer felt it was rather hard to be asked to pay up for damages suffered by skylarking but there is a relevant view of all this held in the Brigade of Guards. There, the Guardsman who left money lying about and had it stolen could well suffer disciplinary action on top of pecuniary loss. The offence would be that of subjecting his all-too-frail colleagues to temptation.

If boys in offices, or works, are left with idle moments, and with paper clips and so on to hand, it is a sobering thought that the employment our ancestors would say the Devil found for them may legally be the responsibility of the employer.

Post-Graduate Diplomas at Northampton College

The Northampton College of Advanced Technology has founded a series of full-time post-graduate courses designed to meet the demands of industry for men with specialised knowledge far in advance of a first degree or diploma in technology.

Meetings of learned societies, practical contact with others engaged on the work, and reading the available books are all possible methods of gaining the necessary knowledge but none possess the advantages of a full-time intensive post-graduate course covering a whole session or longer.

At the Northampton College, the courses will embrace formal lectures, discussion periods and experimental work. The period of time will be an academic year of three terms. The College is aware that some firms may be reluctant to release the young graduate for a year and they suggest that one way round this could be for the "year" to be accomplished by three terms spread over three years.

This compromise, while better than no course at all, seems likely to impose strains on everybody. The employer is going to be a long time gaining the benefit of the course and the post-graduate student to suffer the mixed blessing of a year's interval between the start of each session. What wants facing, and it is to be hoped that enough firms will do so, is that the more valuable contribution to industry of the highly-trained holder of the College's post-graduate diploma (D.N.C.L.) is well worth the year's absence from the works of the particular organisation.

The diploma courses, as at present foreseen, are:

Highway engineering and bridge design
Engineering materials
Automatic control
Aeronautical engineering
Servomechanisms and regulators
Mathematics for engineers
Physics of semi-conductors

The course in mathematics for engineers covers finite differences, linear algebra, vector analysis, complex variable, operational analysis, ordinary differential equations and partial differential equations, special functions and calculus of variations.

Chebychev

The heads of subjects listed under special functions are an indication of the breadth of subject matter the student will have before him in the three-term course. They run: Bessel, Legendre, Laguerre, Hermite, Chebychev, elliptic and generalised exponential functions; tabulation of functions; representation of functions as series of Chebychev polynomials; least square curve fitting by Gram polynomials.

It is normally intended that the courses will start in the first week of October. Application for registration as a post-graduate student should be made to the secretary of the College at St. John Street, London, EC1.

ICI Handrail Hazard Removed

As a symbol of safety precautions the handrail might be hard to beat. Not quite so obvious is the fact that the handrail may itself be a risk, and a fire risk at that.

At the Imperial Chemical Industries' Billingham plant the fire risk from handrails came about because of the necessity of arc-welding the solid rods forming the rails.

Flying sparks were falling close to equipment.

Now the services section of Billingham engineering works has designed a welding box which catches the sparks and also shields the welder's arc. The box, which slips over the handrail before welding begins, has a hole only large enough to allow the entry of the burning nozzle, preparing the ends of the bar, and the entry of the electrode for welding.

A cloth held by the welder's mate, and the body of the welder, provide a screen for that arc flash which still escapes from the box.

Engineering Growth in Wales

Prosperity abounds in an area once notorious for its unemployment problem. More new factories are going up, and the metal-producing plants which are a dominant feature continue to expand.

By H. J. Novy

SINCE the war, industry in Wales has expanded at nearly double the rate for the country as a whole. So much new industry has been introduced, especially in South Wales, that one of the region's chief problems is to find the time to assimilate what has been acquired.

At the present time some 31,000 new jobs are in prospect from recent decisions to build new factories or expand existing ones, most of them in South Wales. In Wales as a whole, however, there are only 28,000 unemployed—some 2·9 per cent of the working population, and 7,000 of these are in North Wales.

The problem the region is facing, therefore, is not one of finding employment for its people. It is one of establishing a stable economy. It is also one of repopulation after nearly half a century of depopulation. I found on my tour much cheerfulness and optimism but also an awareness that the Welsh economy remains vulnerable. Why this is, and how it might be overcome, emerge from the region's own history. One peculiarity of Welsh industry is that it makes principally materials and very few end products. The bulk of new industry, or of existing industry's expansion, has been in the field of materials, steel sheet, tinplate, aluminium and nylon.

In 1923 some 65 per cent of the working population was engaged in the production or transport of coal, steel, and tinplate; in 1960 this proportion has fallen substantially, but I doubt if it is less than 40 per cent.

The origin of Welsh manufacturing industry lay in the deposits of high-grade iron ore, and in its coalfields which contain the richest low-volatile coal producing deposits in the world. They lie in a small area bounded on the west by Llanelly and on the east by Cardiff, extending for about 25 miles inland.

THE SCARS

Between 1921 and 1938, 400,000 people left Wales, most of them men and women of working age, looking for jobs which they found in the Midlands, London or overseas. During the ten pre-war years, unemployment averaged 30 per cent of insured workers. In most of the mining communities between 50 and 60 per cent were without jobs. A large proportion had never been in a job until the war started.

The cost of those hard times has been heavy, and the scars are visible now, even after two decades of full employment. Social amenities are far behind those of other regions, housing is inadequate and what exists is backward. Hotels are too few, the roads too narrow, the schools too small. It would be wrong to ignore these facts, for they have left a deep imprint on the minds of the people. To them the new deal they are now getting is a flood of bright sunshine, but however hard they try to adapt themselves to prosperity they cannot avoid being affected by their memories of the past.

The working population of Wales totals some 950,000, of whom 700,000 work in South Wales and Monmouthshire. Industrial growth there since the war has been tremendous. To a large extent it has consisted of expansion in steel and non-ferrous metal firms already in the area.

The expansion of metal manufacture in South Wales, measured in factory area (not an ideal unit of measurement since much of the increased capacity came from the replacement of old plant by new) amounted to 8·27 million sq. ft—greater than in any other region except the Midlands. The second largest expansion—3·48 million sq. ft—came in textiles, nearly all of it centring round man-made fibres, followed by chemicals with 3·10 million sq. ft of new capacity.

The pattern of industry from the point of view of employment, is indicated by the Ministry of Labour statistics. In South Wales and Monmouthshire mining remains the largest employer, accounting for 16 per cent of the 700,000 labour force, followed by metal manufacture with 12 per cent. Various metal-using industries, such as shipbuilding and ship repairing, mechanical and electrical engineering, motor vehicle manufacture, metal goods and instruments together accounted for 12½ per cent.

An analysis of the main manufacturing industries of Wales shows that "metal manufacture" (i.e. production of metals) is clearly the region's major industry, with a net output in 1954 of £93·1 million and a labour force of 73,920—a relatively high net output per worker. Mining, although a larger employer of labour—130,000—has a low net output per worker and earns less for the region than steelmaking. "Engineering," shipbuilding and electrical goods had a net output of £33·9 million and employed 42,850. "Vehicles (all components), aircraft and railway locomotives" had a net output of £13·193 million and employed 20,730, while metal goods such as tools, chains, wire, and hollow ware had a net output of £15·19 million with an employment figure of 21,440. These figures were obtained from the Census of Production for 1954, but as so much progress has been made since then it is less up to date than for other regions, and I have therefore omitted the usual table showing net output and employment of major industries.

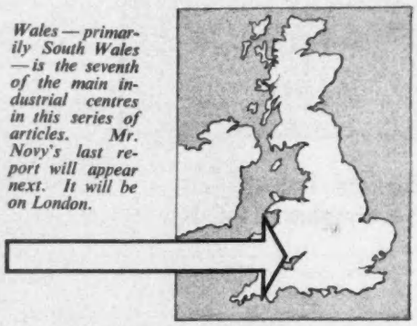
I would draw attention to these significant points:—

(1) "Metal manufacture," which is developing rapidly and benefits from the most modern plant and techniques, is largely of rolled products, sheet strip and tinplate which are used mainly in the manufacture of cars, household appliances and office furniture on the one hand and for the packaging of processed foodstuffs on the other. This applies with almost equal force to the aluminium industry in Wales. The activity of these industries is dependent above all on a high level of consumer demand at home and on the continued success of British consumer goods in overseas markets.

(2) The coal industry is largely dependent on the activity of the steel mills, both directly (coking coal) and indirectly (thermal electricity).

(3) Large numbers are employed in the building and contracting industries, due to the exceptionally heavy demand for new factories. At the end of March last year the area per worker of industrial buildings under construction stood at 7 sq. ft—twice the figure for the country as a whole and higher than for any other region in the British Isles except the Eastern Region.

Despite the fact that industrial growth in Wales has been mainly on traditional lines, 400 firms have come there since the war and some 150,000 new jobs created. I visited the three organisations whose job it is to see that this process is continued and to ensure that the economy of Wales is established on a sound basis. The first was the regional office of the Board of Trade, who carry out research into the region's industrial development, assist their headquarters in steering new industry into Wales, and provide guidance and advice to inquiring industrialists on the factors involved in selecting a location.



Wales — primarily South Wales — is the seventh of the main industrial centres in this series of articles. Mr. Novy's last report will appear next. It will be on London.

My second visit was to another agency of this Board, the Industrial Estate Management Corporation for Wales, in Treforest, where they have their largest estate. The Corporation manage five estates, including a new one at Swansea, and 137 industrial factory sites, 110 of which have factories erected by the estate company. In addition, 15 factories are currently being built.

It should be made clear that although the first estate—Treforest—was started in 1936, employment for only 5,200 people was provided on their sites before the war began. Over 11,000 new jobs were created during the war but the balance—44,500—have been created since.

LACK OF DIRECTION

One of the deficiencies of the industrial estate policy which I discussed in my article on Northern Ireland is the apparent lack of direction from which it suffers. Only one factory, of 25,500 sq. ft, is being built in advance of demand (at Holyhead). The process of deciding what kind of industry Wales needs and thereafter setting out to develop suitable sites with the appropriate sources does not appear to have even begun. Advance buildings are a great attraction in times of rising industrial activity, since they save precious time when management have made their decision to expand, or move, or start something new.

After my visit to Wales I felt even more strongly than before that a well thought out policy, and a little initiative and courage, would make possible a much more effective use of a region's facilities and would gain greater stability for the region than the mere offer of subsidies and various other incentives.

My third meeting was with a new organisation, the Development Corporation for Wales Limited, which was started in September, 1958, by a group of local industrialists with the object of making "a determined drive to attract more new industries." The Corporation's chairman is Sir Miles Thomas, who is chairman of Monsanto Chemicals.

The Corporation's first annual report (published March, 1960) underlines the relative plenty of labour, particularly female labour, in Wales, especially in North Wales. The percentage of women in employment is only 28 per cent compared with 33 per cent in Britain as a whole, which they say "suggests that there is a reservoir of female labour in Wales which might be drawn upon by attractive new industry." Another source is the Welshmen outside Wales, many of whom wish to return, and might do so if employment opportunities became available.

One encouraging item in the report concerns research "to enable the Corporation to deal with location and other problems as they arise." If they are to fulfil their main purpose, which is "the further strengthening of the Welsh industrial economy, primarily by the introduction of additional industry of suitable type in suitable locations," they will need all the research they can undertake.

The main points to bear in mind concerning the introduction of new industry into Wales are: (1) that full employment would have been

achieved before now had not the modernisation and concentration of the coal and steel industries involved substantial releases of labour; (2) that practically no capital goods are made in Wales; and (3) that approved new projects, discussed below, call for 31,000 new workers compared with a total unemployment (April) of 28,000.

COALFIELDS

The main coalfield of Wales is in the south, where current annual output exceeds 22 million tons. Coal production in South Wales (the South West division of the National Coal Board) exceeded 57 million tons at its peak before the First World War, and exports were 60 per cent greater than present total output.

There are, however, plans to raise production to 24-26 million tons by 1965, when the NCB estimate that South Wales will produce 12 per cent of British coal with 15 per cent of the labour force. A possible decline from the present level of employment is envisaged, from 94,000 to 90,000 over the next five years, but a higher level of capital investment has been planned.

The Board point out that most of the reserves consist of high-grade coking coals and of anthracite and low-volatile coals, which are in strong demand. Nearly all the collieries producing anthracite and low-volatile coals in 1965 will either be new pits or ones that have been reconstructed. In the coking coal areas, 85 per cent of the output will come from new or reconstructed mines. Redundancy will probably occur as the schemes proceed, largely because the geography of the coalfields makes redeployment difficult. But even at the lower level of employment which has been forecast, coalmining is likely to remain the major employer of Welsh labour for at least another decade.

Considering now the process industries, oil and chemicals, the hopes raised by the building of a refinery at Llandarcy in 1921 were never realised. There was little expansion until the war came, and no ancillary industry sprang up to make any of the products which can be produced from oil.

Perhaps the main cause was that it was the first, and ahead of the research which made these developments possible. During the war, however, £25 million was spent on expansion and capacity raised to 3 million tons a year. It is now being connected to the deep-sea harbour at Milford Haven, 60 miles to the north west, by a pipeline and further expansion is therefore likely.

After the war, Esso Petroleum decided to build an oil terminal and a refinery at Milford Haven with a capacity of 4½ million tons a year, and BP are building a similar terminal to unload large tankers into the new pipeline to this Llandarcy refinery. A total investment of some £25 million is involved, and it is now likely that a major oil industry will be operating in Wales within a few years and that ancillary process industries will be introduced.

The chemical and man-made fibres industries have also expanded considerably since the war. British Nylon Spinners employ 5,000 in the factory built in 1948 at Pontypool and have recently added a new textile development department to this major unit. Courtaulds, who share with ICI the ownership of British Nylon Spinners, have two rayon plants and one sulphuric acid plant at Flint and Holywell, where they employ over 4,500 people.

Monsanto Chemicals have two plants in Wales: at Ruabon in Denbighshire where they make pharmaceutical products and at Newport where products range from plastics to detergents. The Distillers Group have several plants at or near Barry, where they make calcium carbide and carbon dioxide (using coal as a raw material), synthetic resins and plastics raw materials. Imperial Smelting Corporation at Swansea produce zinc metal and sulphuric acid. ICI at Dowlais make (from coal) methanol and ammonia, some of the latter being supplied to BNS's nylon works. British Glue and Chemicals at Newport make a wide range of chemicals and have developed a new process to obtain protein from vegetable material, such as grass, groundnuts, etc. Mond Nickel have at Clydach the largest nickel refinery in Europe, where they employ a unique chemical process for the extraction and refining of the metal.

Permutit at Pontyclun make all types of ion exchange materials used for water treatment and in a wide range of industrial and chemical processes.

This range of process industries appears to have a good basis for further development, particularly as industries using oil as a raw material are attracted by the important developments in that field.

In the building of new plants at Margam, Trostre and Velindre, and in extensions and modernisations at Ebbw Vale, Shotton, Brymbo and elsewhere, the steel industry has committed itself to an expenditure of nearly £300 million. Aluminium plants at Rogerstone and Dolgarrog have expanded to the tune of £10 million and schemes costing £3 million are being implemented to increase the production of zinc (ISC) and titanium (ICI), both at Swansea.

The Steel Company of Wales was formed in 1947 because the sheet steel and tinplate industries of South Wales were in need of urgent extensive modernisation and this was too large a task for the companies concerned to undertake single-handed. It has now carried out three major development plans in the course of which some £180 million has been spent and a further £20 million is scheduled. When the last scheme has been completed, ingot steel capacity will be increased from 3 million to 3·6 million tons. The Steel Company of Wales currently employ 25,000 people and make three-quarters of all tinplate, a third of the sheet steel and a half of silicon sheet steel in the United Kingdom.

The other two major steel producers in Wales, Richard Thomas and Baldwin at Ebbw Vale, and John Summers at Shotton, have also expanded considerably since the war. Richard Thomas and Baldwin constructed Britain's first wide-strip mill at Ebbw Vale in the late 1930's, and were the pioneers of electrolytic tinplating in the country. They have spent some £30 million since the war on expansion and improvement, and are currently proceeding with an electrolytic tinplating line using the Linz-Donau process and operating at 1,500 ft per minute. At Newport, Richard Thomas and Baldwin are building a fully integrated steel works and strip mill at an estimated cost of £110 million. Initially they will employ 6,000 workers but when the site has been fully developed, 18,000 will be needed.

John Summers at Shotton have developed 600 acres of their 8,000 acre site on the banks of the river Dee and spent £54 million since the war. A new £20 million scheme will raise output by a half to 2 million tons a year. In Cardiff, Guest Keen Iron and Steel Co. have an expansion scheme for their East Moors plant costing £6¾ million, to raise annual production to a million ingot tons by 1963.

MECHANICAL

I have already indicated that Wales does not have a substantial mechanical engineering industry (using "mechanical engineering" in the narrow sense) and that most of the output is centred on the processing of sheet and strip. Nonetheless there has been considerable growth in engineering since the war, particularly in the trading estates which have attracted a fair number of light engineering firms. I visited two firms which are somewhat untypical of the region's industry but should provide a good guide as to its suitability for the manufacture of plant and machinery.

British Overseas Airways Corporation overhaul aircraft engines at Treforest, where they employ about 1,000 people. During the war some 2,500 workers were engaged on the reconditioning of RAF engines and a fine nucleus of skilled fitters and machinists was trained around the 400-odd skilled men brought into the area from Croydon in 1940. Local labour was trained in a Government training centre on the estate and there is now no difficulty in getting good quality fitters and machinists, with the possible exception of grinders.

The other firm I visited is the South Wales Switchgear Company, a member of the Aberdare Group. They began at Blackwood in 1942 with 25 workers and now employ over 2,000 people on the manufacture of switchgear and transformers at Blackwood and Treforest. The company's management attribute their success to the great care and considerable investment in the training of local workers. The managing director, Mr. A. J. Nicholas, C.B.E., is one of the leading proponents of youth training and the company have operated an apprenticeship scheme from the start. Only a small number of skilled workers were imported, mainly from Lancashire. There are nearly 340 apprentices undergoing training, including five girls. Local schools and technical colleges are used for further education.

The company recruit seventy apprentices each year, but with some difficulty in the case of student apprentices. While education is on the whole very good in Welsh grammar schools, there is a tendency on the part of parents to influence their children away from industry, into teaching and the liberal professions. South Wales Switchgear, like other firms in the region, cannot make direct contact with the shools, but invite, through the local Youth Employment Officer, boys and girls each year to spend a week at the factory. They also have a graduate training scheme lasting two years. There are now some 15 graduates working in the company and others undergoing training.

QUICKLY TRAINED

Important new additions have been made to South Wales' engineering strength. Among the leading firms are Simmonds Aerocessories, who employ 2,000 people at Treforest. Hoover at Merthyr and AEI-Hotpoint at Llandudno both making washing machines and are expanding rapidly. Each has a £2 million expansion scheme. The managing director of Hoover, who employ 3,000 people at Merthyr, commented that local workers were "intelligent, enthusiastic and among the best in the world . . . quickly trained and, above all, most loyal."

The recent decisions of Pressed Steel, BMC and Rover to start manufacture in South Wales will increase the region's engineering labour force by over 10,000 in the next two to three years. Pressed Steel's factory, in which they will produce refrigerators, is being put up by the Estate Corporation near Swansea docks. The total investment is estimated at some £5 million and weekly output will exceed 8,000 units. BMC, who already make radiators at Llanelly, will build a new plant for the production of steel pressings on a site west of Swansea where over 4,000 workers will be needed.

The prospects for Wales are excellent so long as the demand for cars and household appliances continues high. The high level of activity of the past four years has led to improvements in rail, road and port facilities. The South Wales Docks of the British Transport Commission are spending a lot of money in adapting their facilities. There is every prospect of greatly improved communications with the Midlands and with London, which should make South Wales one of the most accessible industrial areas.

Five new power stations built since the war and new gas grid lines, as well as major advances in gas production techniques, have greatly improved supply facilities. The new industrial projects now in hand will make heavy demands on available labour in the Newport-Cardiff-Swansea area, but some pockets of unemployment will remain in the north, in the north west and in mid-Wales.

The Welsh problem is therefore very different from what it was between the wars. It could become, within a few years, a problem of repopulation to permit further growth. A momentum has now been acquired and further large scale industrialisation is virtually certain.

Mineral Wealth of Sahara Poses Problems

During the past decade increasing attention has been focused on the valuable mineral resources of the Sahara. Some difficult economic problems are posed by this new-found wealth.

THE wealth of the Sahara in oil, natural gas and other minerals, especially iron ore, is going to play a big part in the development not only of North Africa but of France and some other European countries as well.

It is not so very long since the idea of finding and exploiting mineral deposits in the Sahara was looked on as the concern only of what the French call "les visionnaires." As recently as 1949 the chief geologist of a big American oil company declared that there were few oil bearing measures under the Sahara. Nevertheless in 1954 the enormous natural gas reserves of Djebel Berga were discovered. Since then the exploration phase of Saharan development has been followed by exploitation. Today the prospects of large shipments of natural resources are being added up into definite forecasts.

It is believed that between 5 and 16 million metric tons of iron ore will be produced by 1962. These will come from Miferm, 6 million metric tons, and Gara Djedilet 10 million metric tons. Production of some 9 million metric tons of copper is forecast from the Micuma region. The Sahara is expected to yield some 24 million metric tons of crude oil by 1962. No forecast is made for natural gas as it is very difficult to say how this would be transported or where it would be sold.

The whole question of markets is fundamental to the success of the French exploitation of the Sahara. Five or six years ago the prospect of new sources of supply of energy would have been welcomed everywhere in Europe. In 1956 the Hartley Report on European fuel needs published by the OEEC forecast continuing scarcity. Yet only four years later the position has completely changed and Western Europe has more coal than it can use, plentiful supplies of imported oil and nuclear power stations that are not nearly so necessary as their planners and builders expected them to be. What is likely to be the position then of new supplies of oil and natural gas suddenly appearing on a market that is already well supplied?

Many difficulties are involved. In the first place Saharan crude is not really suited to European requirements. It contains about 46 per cent petrol and little heavy fuel. While it would be possible to make heavy fuels from Saharan crude it would be extremely expensive and not an economic proposition for the French market. This means that purely in terms of what they have to sell the exporters of Saharan oil will have considerable problems in the very market where they would expect top sales. The answer seems to be that Saharan oil will have to be used in North Africa and at least a third of total output should be exported.

The next problem is to find where to send the exports to. The world market for oil is already well supplied and most of the big users of oil and petrol have considerable sums tied up in different producing areas. Thus the United States, which as the world's greatest consumer of petrol would seem to be the natural market for Saharan crude, already has its investments in the Middle East oilfields. This would raise difficulties both in the United States and the Middle Eastern States that rule out any prospects of big sales of Saharan oil in America.

And in France itself the switch to the new sources of supply would not be at all easy. Over 60 per cent of the distribution system in France is controlled by subsidiaries of foreign oil companies. The partly state-owned CFP (Compagnie Française des Pétroles) is the only French producing company with a distribution network in France. But CFP already has commitments in Iran, in addition to its interests in the Sahara, which must be met. And to make the problem even more complicated the independent state of Libya has also discovered oil and this is being developed at the same time as that of the French Saharan territories.

Another set of problems that has come up in connection with the appearance of Saharan oil relate to the European Coal and Steel Community. The French desire to obtain preferential treatment for Saharan oil in the framework of a European long-term energy policy is deeply resented by the other members. When the ECSC was set up the Germans in particular leaned over backwards to meet the French demands for special treatment in the coal market. Ruhr coal at special rates has been shipped to Lorraine under the ECSC Treaty.

Now that the position has changed the French have lost much of their enthusiasm for the ECSC, at least so far as its control of the coal industry is concerned. The demand now is for a coordinated energy policy in which not only ECSC but the other two six-nation bodies, Euratom and the EEC (European Economic Community) would be involved.

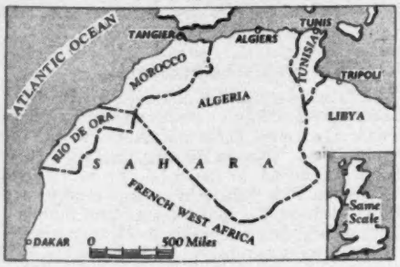
One proposal put forward by France has been for a system of tariff quotas for refined oil to apply in the European Economy Comminity (the Common Market). This would have to be agreed as part of the List G discussions which deal with the items on which the common tariff

Preparing explosive for a seismic sounding.

levels were not fixed at the time of the Rome Treaty. The French proposal has been left over for a report by a study group set up jointly by the ECSC and EEC.

But any plans for switching sources of supply and persuading the other members of the European Economic Community to admit agreed amounts of Saharan oil is clearly going to be a lengthy business. And although the immediate problem is only how to dispose of the 10 million metric tons of Saharan oil coming to France next year the whole question of long-term investment in drilling equipment, pipelines and storage, tankers and refinery capacity has to be considered.

Many decisions have already been taken on the refining and transport arrangements. BP's French subsidiary SFBP has signed an agreement with SNREPAL, the state-owned concern which has a half-share of the Hassi-Messaoud oilfield. Under this contract SFBP is reported to be taking 880,000 tons of crude from SNREPAL in the present year, 1,150,000 tons in



1961 and 1·4 million tons in 1962. SFBP is also said to be negotiating contracts with French producers in the Edjele field and in Gabon.

Shell-Francaise, the French subsidiary of Royal Dutch Shell, is expected to buy about 2 million tons of Saharan crude this year. Of the rest of the Saharan output in 1960 some 5 million tons will go to the CFP for sale through its own petrol pumps both in France and Germany. The remainder is being handled by SNREPAL.

While the situation of Saharan crude oil is difficult that for natural gas is practically impossible. The discoveries of the great reserves at Lacq in the South West of France have taken care of the French market very effectively. Lacq gas is now being piped to Paris and other cities.

Enthusiasm for shipments from the Sahara is therefore somewhat restrained. Two main possibilities are being discussed. One is that the industrialisation of Algeria under the Constantine Plan should be based on natural gas. This proposal may very well be accepted. The major difficulty is that the amounts involved would in the first place be quite small. Algeria could meet all its power needs from Saharan gas for centuries ahead. Desirable as this might be it comes up against the hard economic fact that if the Saharan gas is to pay exploitation costs it must be sold on a very large scale. Otherwise transportation costs per unit will make the whole operation completely uneconomic.

The other suggested solution is that Spain and other Mediterranean countries that are short of industrial fuels might be interested in buying Saharan gas on a big scale. The Spaniards are said to be very interested in this prospect and a joint committee has been set up to examine the problems involved. So far as transport is concerned two main suggestions have been made. One is for a submarine pipeline across the Mediterranean. The other is that special refrigerated ships should be employed to carry gas from North African ports. At the moment the whole future of the exploitation of natural gas from the Sahara is somewhat problematical. No forecasts for production or exports have been issued recently and the official policy seems to be one of extreme caution.

All told then the Saharan resources have not been an unmixed blessing to the French. The most likely raw material to start paying off is iron ore. The World Bank recently made a loan to help in developing the transportation of ore from Mauretania in the South West Sahara. For oil and gas the situation is much more difficult. Does this mean that France will not be able to profit from his newly discovered natural wealth? By no means. The whole process will however be very much slower and more difficult to carry out than it would have been if the "visionnaires" had been successful ten or twelve years ago. There will no doubt be a gradual change over to Saharan oil by CFP and the effort to sell abroad will be kept up. The fact that Saharan oil is close to the industrial centres of Europe will become more important as the pipelines begin to deliver increasing quantities of crude to the North Africa ports. The only real certainty in the whole Saharan question is that the optimistic view taken a few years ago of France as the power supplier of Europe is right out of date.

Nuclear Market

THE third part of the proceedings of the Stresa Conference on the Industrial Challenge of Nuclear Energy has now been published by the OEEC. (The Industrial Challenge of Nuclear Energy. Stresa Conference Part 3. The Market for Nuclear Materials. HMSO, price 18*s* 6*d*.) This deals with fuels, moderators and special metals. The two volumes previously published were reviewed in Atomic Review, 8 January and 8 April, 1960.

The Market for Fuels

Up to the Second World War uranium was a by-product of the industry producing radium for therapeutic and other purposes. The discovery of nuclear energy reversed this situation so that although its production and uses have increased, it is radium which is now the by-product. The degree of certitude of the existence of proven rather than "possible" or "probable" reserves is very difficult to define. The published reserves of various countries are shown in Table I. The figure of 0·0285 per cent

TABLE I.—*Published Uranium Reserves*

Country	Ore (metric tons)	Uranium content Per cent	Uranium content Total metric tons
Canada	340 million	0·086	292,000
South Africa	1,000 million	0·0285	285,000
United States	75 million	0·225	169,000
France	—	—	38–76,000
Italy	—	—	5,400
Belgian Congo	—	—	5,000
Australia	—	—	11,500
India	—	—	35,000
Total approximately	—	—	850,000

uranium content shown for the South African reserves, although very much lower than that for Canada or the USA is nevertheless an economic figure as the uranium is a by-product of gold mining.

Towards a Free Market

Between them the United States, Canada and South Africa account for some 30,000 tons of the world total of 32,800 ton uranium production. The present trend of demand shows a fall in Government purchases, and less buying by private concerns than was expected once. During and immediately after the war the whole uranium output was bought by governments at contractual prices. As government demand has slackened and production increased, a freer market has developed. However the demand from industry has risen slowly so that at the present time there is a surplus of uranium. Forecasts of future trends are difficult for two main reasons. Nuclear power station programmes are by no means settled either as to extent or timing, or type of reactor to be used. And requirements for military purposes are not disclosed and can only be guessed from the purchasing policies of the governments concerned. The US Atomic Industrial Forum, making all due reservations, has estimated that the free world's total aggregate requirements of uranium metal will amount to 80,000 tons between 1958 and 1965. The European Nuclear Energy Agency (ENEA) forecasts a demand of 40,000 tons "towards" 1965. The report comments that "these figures are not incompatible."

Hemmed in by Restrictions

As natural uranium, enriched uranium and plutonium are dangerous materials, governments have introduced a variety of regulations for their control. At national level the governments generally subject nuclear materials to compulsory declarations of production, use, processing and stocks and in varying degrees fix the price. In view of the scale of State transactions the market is in fact governed by the published prices at which governments buy and sell nuclear materials. Raw materials such as natural uranium can usually be owned by private bodies. Special nuclear materials such as enriched uranium and plutonium are restricted to the sole ownership of governments or inter-governmental bodies such as Euratom. At international level control can be exercised through the provision of multilateral treaties such as the Euratom Treaty, or bilateral agreements such as that between Britain and the United States.

Prices and Reserves

The price of natural uranium has fallen steadily over the past few years. The report quotes a price of $8 per lb for uranium of U_3O_8 in concentrations of 80 per cent "as the basic price for world transactions." The price of enriched uranium is shown in a USAEC schedule which is said to reflect faithfully production costs at the Oak Ridge plant. The price of plutonium is fixed by governments both for sales and for government repurchases of fuel used in power stations The report estimates that at the 1965 rates of use and production proven reserves will be exhausted in 25 years' time. However, annual demand will probably increase rapidly, although no doubt new deposits will be discovered. If these contradictory factors do not offset each other, uranium reserves will only cover world needs for a few decades, which, as the report remarks, "is not a very long time." The big question mark over the estimates is that they take no account of the possibility of breeding plutonium from uranium 238. This process would practically put an end to the use of uranium for renewing the depleted cores of existing nuclear power stations. Only the initial charge of new plant brought into service would therefore have to be allowed for. Just what reduction this would mean in annual uranium consumption is not easy to estimate. It depends on two highly uncertain factors, burnup, and the annual rate of increase of installed nuclear capacity. However, the report estimates that it should "not be far from a coefficient of 10" which would mean that the world has sufficient uranium reserves to last for several centuries rather than several decades.

The conclusions of the report on the market for fuels can be summarised as follows.

1. A nuclear energy industry can be based on uranium since (*a*) world reserves are adequate, (*b*) reserves are well dispersed between various countries, and (*c*) world capacity for production and refining is adequate.
2. The incidence of the price of uranium on the cost of energy production is weak and tending to fall.
3. Uranium compounds (metal, alloys, oxide salts) are available on normal commercial terms.
4. Prices of these compounds are increasingly subject to the law of supply and demand.
5. Although trade in nuclear materials is under strict controls these do not hamper their use for normal industrial and scientific purposes.

Graphite Moderator

Graphite is chiefly used for nuclear purposes as a moderator and reflector in thermal reactors. The introduction of impermeable graphite makes its use possible for canning fuel elements for high temperature reactors. Natural graphite is found in the form of flakes in a mineral gangue. It is not used in nuclear energy owing to its impurities. Artificial graphite can be manufactured from carbon in any form but the material generally used is petroleum coke. To manufacture impermeable graphite various processes have been perfected particularly by the Royal Aircraft Establishment, Farnborough. Graphite tubes treated by these processes remain impermeable at temperatures of over 800° C. The demand for nuclear graphite in Britain and France is shown in Table II. The quantity of graphite needed per

TABLE II.—*Initial Charge of Graphite in Selected Power Station*

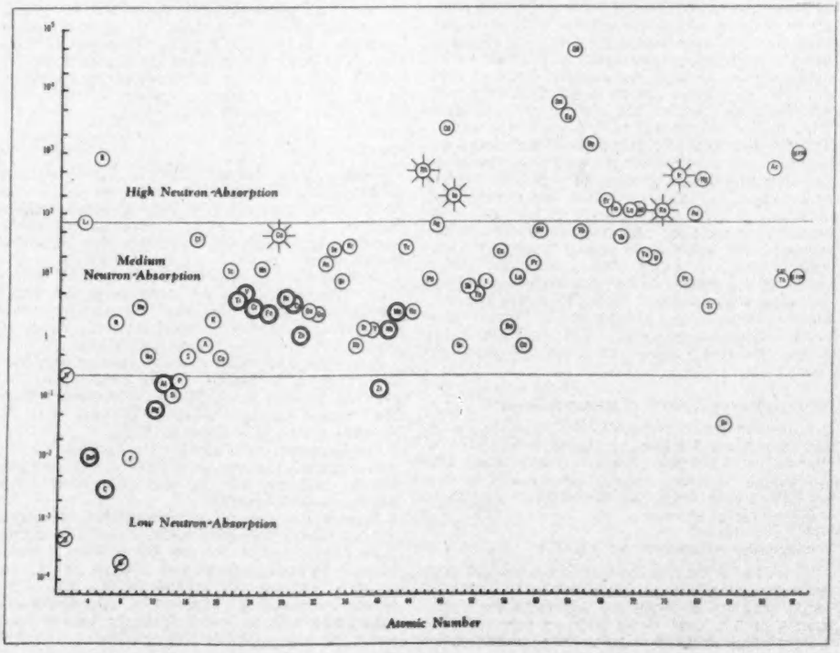
Station	Net capacity, MW(e)	Total weight of graphite per plant (tons)	Weight of graphite, tons per MW(e)
Berkeley (UK)	275	4,000	14·5
Bradwell (UK)	300	3,760	12·5
Hunterston (UK)	300	3,760	12·5
Hinkley Point (UK)	500	4,000	8·0
G-2 (France)	30	1,200	40·0
G-3 (France)	30	1,200	40·0
EDF-1 (France	63	1,200	19·0
EDF-2 (France)	170	2,660	15·6
EDF-3 (France)	300	3,000	10·0

MW(e) of installed capacity varies between 12 and 50 tons. The introduction of reactors of ever-larger unit capacity is expected to bring a proportionate decrease in the amount of graphite required. It is estimated that from 1958 to 1964 14 tons per MW(e) will be required and 12 tons per MW(e) for 1965. Installed capacity for 1965 is estimated at 4,500 MW(e) for the United Kingdom and 4,000 MW(e) for other OEEC countries. The total graphite-moderated natural uranium plant by 1965 is estimated at 5,500 MW(e). From now to 1965 the requirements of graphite in the form of machined bricks is estimated at 80,000 tons. As about twice as much unworked material is required, the demand for crude graphite will be approximately 150,000 tons up to 1965. In that year the report forecasts a demand for crude nuclear graphite of 40,000 tons. In addition there will be a further much smaller amount required for research reactors, but no forecasts are possible for this item. The use of impermeable graphite for fuel cans is envisaged only for high temperature reactors. The principal examples of this type are the OEEC Dragon project and the Brown Boveri-Krupp reactor in Germany. Up to 1965 for the total requirements of impermeable nuclear graphite the report forecasts a demand of "between a few tons and a few dozen tons."

Graphite Producers

Up to the end of 1958 the majority of nuclear graphite was produced by the British company ACHESON ELECTRODES Corporation Limited, in

Fig. 1 Neutron cross sections of nuclear and other materials.



association with Union Carbide. Early in 1959 a graphite plant was completed at Newburn Haugh Newcastle upon Tyne, for the ANGLO-GREAT LAKES Corporation Limited. This plant will turn out 10,000 tons a year of nuclear grade graphite in brick form for reactors and 5,000 tons of electrode and anode graphite. The graphite now being produced is for the Bradwell power station. Other firms also producing graphite are POWELL DUFFRYN Carbon Products Limited (associated with GEC); UNION CARBIDE Nuclear Graphite Division of Union Carbide International Co., Sheffield; NUCLEAR GRAPHITE Limited (Morgan Crucible Company Limited and AEI-John Thompson Nuclear Energy Company); and ENGLISH ELECTRIC Company Limited. The entire output of nuclear graphite is bought by the UKAEA for resale to firms building nuclear power stations. HAWKER-SIDDELEY Nuclear Power Company is building a pilot plant designed to reduce the permeability of graphite by the impregnation process. In France nuclear graphite is produced by Société PÉCHINEY by a process developed in collaboration with the Commissariat à l'Energie Atomique. Three firms in Germany make nuclear graphite. They are SIEMENS-PLANIA-GRIESHEIM of Augsburg, whose output is at present sufficient to meet German needs; KOPPMÜHL, producing small quantities; and VEREINIGTE WERKE Dr. R. Alberti, producing graphite for radiation protection purposes. In Switzerland graphite is processed by GRAPHITWERK AG, making all the blocks for the DIORIT reactor at Würlingen. The principal producers in the USA are NATIONAL CARBON Co. (division of Union Carbide Corporation); SPEER CARBON Co., and UNITED CARBON PRODUCTS Co.

Prices and Prospects

The price of unworked nuclear grade graphite for moderators and reflectors is £300 per ton in the United Kingdom. In France it is roughly $1 per kilogram, which is about the price paid by the USAEC for unworked slabs. The report concludes that so far as nuclear graphite is concerned total demand will reach a value of some 150 million EMA, units of account by 1965, by which time annual demand may be at the rate of 40 million EMA units of account. The production of artificial graphite may be regarded as "one of the most typical examples of a large new industry brought into being to cater for nuclear requirements." Production of nuclear graphite is expected to keep pace with demand up to 1965. After this date the situation may change if new types of reactor not requiring graphite as a moderator were to be adopted for power production, especially in the United Kingdom and France.

Heavy Water

As a result of the development of the atomic industry there has been an increase by "a factor of several thousand" in world capacity for heavy water production. The USAEC is now building or planning a number of heavy-water-moderated reactors These include the Heavy Water Components Test Reactor (60 MW(e) by du Pont), the Virginia-Carolinas 17 MW(e) heavy-water moderated and cooled reactor, the second Florida proposal for gas-cooled heavy-water-moderated power reactor and the Sargent and Lundy-Nuclear Development Corporation of America natural uranium heavy-water-moderated reactor study. A number of heavy-water reactors and projects exist in Europe. Examples are the Halden boiling heavy-water reactor, the British test reactors DIDO, PLUTO, and DMTR, the French El-3 reactor, Germany's Orgel and Sweden's power reactors. The two largest heavy-water production plants in the West are both in the United States. The Dana plant, which has a capacity of 300-400 tons of heavy water a year, was closed down in 1957, but is being kept as a stand-by and could be brought back into production. The other American plant is the Savannah River Unit with a capacity of 400-500 tons a year. The NORSK Hydro plant in Norway produces about 20 tons a year, but at higher cost than the American plants. These are the only plants at present in production. A number of pilot plants are under construction.

Large Plant for Europe

The report forecasts growing importance of heavy-water-moderated reactors, but mentions two qualifying factors. These are the cost of heavy water per installed kW(e) which is estimated at $25-$55. This may prove to be a serious limitation. The other drawback is the temperature-pressure limitation associated with the use of water, so that competition from solid moderators and metallic coolants may increase. The report foresees no shortage of heavy water up to 1965, but there may however come a time when present US production may not be sufficient. From the economic standpoint it may be difficult to reduce or indeed equal the present US cost of production. The report urges that "some thought" should be given to the possibility of starting large scale production of heavy water in the OEEC area.

Notes and News

Price of Enriched Uranium Hexafluoride

Revised base charges for enriched uranium in the form of hexafluoride have been published by the USAEC. Fig. 2 shows the variation of charge with enrichment, plotted on semi-logarithmic scales. The current price of natural uranium, taking as containing 0·7115 per cent uranium 235 by weight, is $39·25 per kilogram of uranium, or roughly £6 5*s* per pound. The cost of depleted uranium, also in the form of hexafluoride, drops to $5 per kg below a uranium 235 content of 0·36 per cent.

Air-Cooled Condensers for Continental Climates

By using river or seawater cooling for the condensers of steam generating plants, little advantage is taken of the cold spells in winter to lower the temperature of heat rejection. Designers of nuclear power stations have concentrated so much on raising the top temperature of the thermodynamic cycle in an effort to improve efficiency that possibilities of low-temperature heat rejection have been overlooked. According to Dr. L. Heller, developer of the Heller dry cooling-tower principle, nuclear power stations

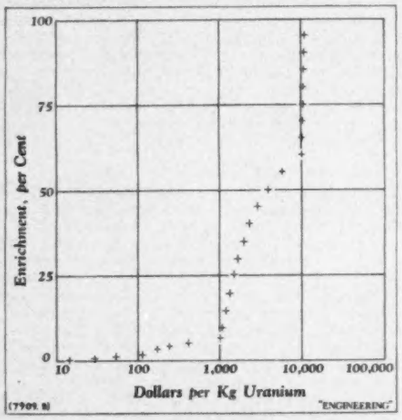


Fig. 2 Price of uranium hexafluoride; variation with degree of enrichment.

are particularly sensitive to variations in rejection temperature. Employing dry cooling towers, a plant can be designed which will operate with an appreciably lower average temperature of heat rejection than a corresponding river-water cooled plant under mid-European climatic conditions. Taking 0·06 atmosphere condenser vacuum as standard, the power output of a nuclear plant will increase by 5·8 per cent if the vacuum is reduced to 0·04 atmosphere, and almost 13 per cent if reduced to 0·02 atmosphere. Important economies accrue not only from the reduction of capital cost as a result of improved average performance, but also from two intangibles: the plant can be sited independently of cooling water sources; and the plant performance conforms to the demand curve much more closely than with river water cooling. A power station using the Heller system of dry cooling towers has maximum output coincident with maximum demand: during the cold winter months. (Dr. L. Heller and L. Forgo, "Das Luftkondensationsverfahren 'System Heller' bei Atomkraftwerken," *Allgemeine Wärmetechnik*, vol. 9, No. 7.)

Pakistan Potential Buyer of Research Reactor

A nuclear centre, complete with research reactor and supporting facilities, is being established by the Pakistan Atomic Energy Commission near Rawalpindi. Further nuclear centres are planned for Lahore and Decca, and the necessary equipment is being ordered abroad.

Radiographic Accelerator for UKAEA

At the end of the year the Atomic Energy Authority will have a mobile linear accelerator for radiographic work, capable of producing high-definition radiographs of 6 in steel plates with an exposure time hardly longer than one minute. The accelerator has been ordered from Mullard Equipment Limited "to take X-ray photographs of the welds in the pressure vessel of nuclear power stations." Purchase of the equipment raises the question as to where and for which power station the accelerator is to be used? By the end of this year the pressure vessels of the first round of commercial stations will be complete.

Further Fuel Fabrication Developments in Europe

Following the announcement of the formation of an international fuel fabrication consortium in Italy (Atomic Review, 6 May, 1960), RIO TINTO announces formation of a joint fuel fabrication venture with DEGUSSA of Germany. The consortium will be called Nuklear Chemie und Metallurgie Gesellschaft m.b.H. (NUKEM), and will be associated with the American MALLINCRODT Nuclear Corporation, a shareholder in NUKEM. The company will manufacture metallic, ceramic and cermet fuels, enriched fuel handling and conversion services, complete fuel elements, and plant for the processing of nuclear materials in cooperation with Rio Tinto's uranium mining interests and Rio Tinto Dow Limited, a company specialising in uranium and thorium processing in Canada.

Rio Tinto and Canadian Uranium

It is certain that Canadian uranium production amounting to 13,000 tons in 1959, will be reduced to about 5,000 tons annually following the decision of the United States Government not to exercise its option for Canadian uranium after 1962, but to stretch out purchases to 1966. Reacting to the changes, Rio Tinto, who produce about 45 per cent of Canada's total, will amalgamate its four subsidiaries into one company and instigate drastic measures to improve efficiency. The less economic mines will be closed down and kept on a maintenance basis, and production will be concentrated in the rich Blind River area. Since last year the Blind River mines have shown improved efficiency and increased yield. Creation of a free market for uranium would find Canadian mines operating at peak efficiency and fully amortised, in an excellent position to meet world competition. Looking into the future, the chairman of Rio Tinto, Mr. Gerald Coke, said that oil will undoubtedly play an increasing part in providing the world's growing needs for power, but burning oil is a wasteful and costly process compared with its use as a raw material for the chemical industry. In the field of electricity generation oil may do no more than cover a small portion of the increasing demand, the bulk must be provided from nuclear energy. "If the nuclear energy programme, in which research and development by their nature are bound to be long term, is to be in a position to meet this need, there is not much time for delay."

Uranium and the Canadian Economy

By 1959 uranium had become Canada's most important mining product. With a value of $325 million, uranium displaced nickel and copper from first place, and as an export commodity it was exceeded in importance only by newsprint, wheat and lumber. The Blind River—Elliot Lake area, containing the world's largest reserve of uranium ore, supplied 74 per cent of the output. (*Monthly Review*, The Bank of Nova Scotia, March, 1960.)

Reactor Notes

Isotopes from Lucas Heights: The Australian Atomic Energy Commission announced that radioisotope production will soon begin at Lucas Heights. Products of the recently commissioned HIFAR reactor are expected to be cheaper than imported radioisotopes.

Sweden's R2 Finally Critical: The material testing reactor R2 of Sweden's AB Atomenergi was finally brought to criticality on 4 May. Originally planned for completion in 1959, construction of the 30 MW(t) reactor was held up by technical difficulties.

Test-Flight for Package Reactor: Martin Company's air transportable nuclear power plant PM-1 has been test flown in an Air Force C-130A cargo plane. The reactor package weighed 15 tons, and the complete plant will be flown in 16 lifts.

Postponement in Poland: The nuclear power station included in the current Polish five year plan will be held over for the next plan, construction starting towards 1968-70.

Reactor Experiments in Tokai-Mura: The Japan Atomic Energy Research Institute is building three reactor experiments at the Tokai-Mura research station: a semi-homogeneous critical facility, an aqueous homogeneous critical facility, and a fast breeder exponential experiment. Fuel for the experiments will be leased from the United States under the Atoms-for-Peace programme.

Kariba the Powerful: Engineering on the Grand Scale

KARIBA *has been built to generate power. In that respect it differs fundamentally from another, much older civil engineering work in Africa—the Aswan Dam—which is for irrigation purposes. Kariba on the River Zambesi, like Owen Falls on the River Nile, is hydroelectric. But the ultimate power potential of Kariba is ten times that of Owen Falls.*

ENGINEERING'S *Construction Editor has cabled the following on-the-site report from Rhodesia.*

AT the dam which Queen Elizabeth the Queen Mother is to inaugurate on 17 May, the waters of the largest man-made lake in the world are now 300 ft up the great concrete wall. Viewed from the air, dam is so near head of gorge, water seems to threaten to surround the dam.

Forty-foot road sweeps along crest of dam. Around site, clearing-up in progress. Civil plant being dismantled. Only one blondin still working. Road surfaces being made good and gantries painted. Second line to south being connected in switchyard. In machine hall, No. 2 set being made ready; operational within few days. Pressure testing about to begin on set No. 4. Machine hall decoration being completed. Pleasing use of white and blue false ceiling and indirect lighting.

In five years since decision was taken to proceed at Kariba, dam built, underground power station for six 100 MW sets hewn out of rock, extra-high voltage (330 kV) transmission grid erected, thriving new town into being and largest man-made lake started to spread over Southern Rhodesia. At cost of £75 million, Federal Power Board, under chairman Sir Duncan Anderson, K.B.E., M.I.C.E., built project without taxpayers' help. Now clear for second stage, 900 MW or more, at cost of only £45 million. Over half to come from revenue earned by completed first stage. Sir Duncan convinced no difficulty raising remaining money. By 1971 second stage complete, cost per unit at substation busbars only one farthing.

By 1971 Kariba no longer sufficient. New projects have to be ready. Possibility Kafue, though irrigation requirements of Kafue flats must be given priority. Major power project on Zambesi below Livingstone and above Kariba Lake also feasible. Perhaps also thermal station on Wankie coalfields, requiring only 240 mile link to new grid. Shire River hydro project in Nyasaland also approved in principle. Federation problem not only increasing population but also rising standard of living of coloured peoples.

Electricity being wired to native towns old and new. New industries also demand power. Copperbelt first to receive power from Kariba. First set now sending 80 MW. Second set will be sending 80 MW to Salisbury.

Rainfall last two years low. Against average of 32 million acre-feet retained there have been only 27¼ million in 1958-59 wet season and expect only 25 million in 1959-60 season. Normal capacity reservoir 130 million; operating storage 36 million. Flood capacity 149 million. All these figures acre-feet.

Compensation water obligatory 10,000 cusecs, equal discharge of two sets as now working. Water level is above spillway cill, so temporary compensation pipes being plugged.

Four more sets to be installed to complete stage one by 1962. Plans in hand for second stage. Cofferdam already completed to protect construction of new intakes on north bank where new station will be built underground. Decision not yet taken about number and size of sets; transport will be prime limitation. Exploratory work begun to prove rock on north bank where second station proposed. New African township to be built on north bank.

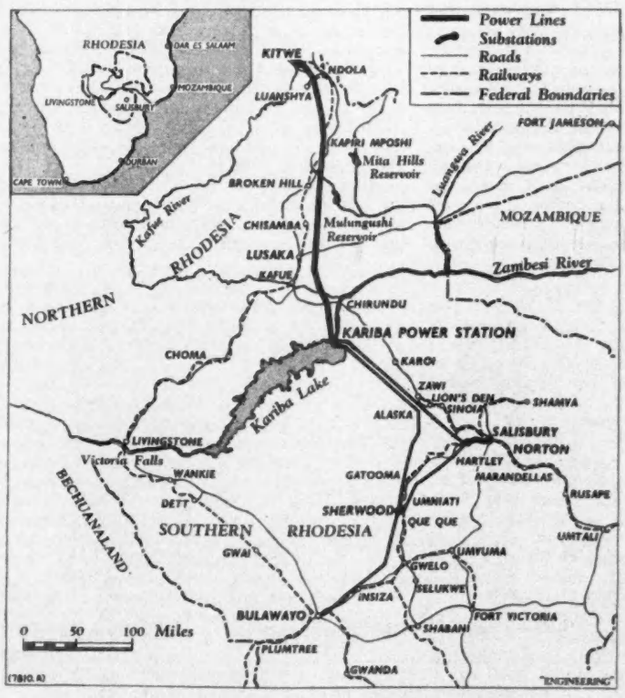
New contracts yet to be made for civil, mechanical and electrical works of second stage.

Very little work to do on grid. Capital cost of second stage only £50 per kilovolt and "fuel" costs negligible.

During construction, African labour force reached 8,000. There were 2,000 Europeans, including women and children. Labour force now down to 350 Europeans, 2,500 Africans. Locals learnt drive vehicles all types including bulldozers but did not handle cranes.

Kariba means that essential step taken to integrate industrial society. Consultative committee set up to extend technical training of Africans. Difficulty making change from basic education to specialist.

Kariba largest project undertaken in Africa. Certainly largest hydro scheme yet in continent. Aswan power development, according present plans, will be larger at 2,400 MW—if completed. Portuguese East Africa considering project at Kabrabrassa on Lower Zambesi that will produce lake twice Kariba.



Kariba Lake, now forming behind the dam, will be 175 miles long. The map shows, in addition, the electricity supply grid which Kariba is feeding.

SIX KARIBA REPORTS ON THE FOLLOWING PAGES

Double-Curve Design Gives Thinner Dam 652
The Big Rush to Get the Main Work Started .. 653
In Spite of Floods the Dam was Early 655
140,000 h.p. Turbine, 720 ton Generator 656
Transmitting the Current from Kariba 658
The High-Level Plan First 659

Double-Curve Design Gives Thinner Dam

The dam—a double curvature concrete arch construction—is located in a gorge with steep slopes and parallel banks. Model analysis was used to refine the design of both the dam and water intakes.

THE location of the dam is where the River Zambesi cuts a gorge, 15 miles long and 600 ft wide at its base, through a rock cap of gniess which overlays the main strata of the area, which are of the pre-Cambrian era. The slopes of the gorge are relatively easy (1 in 1½) and, at the chosen site, first suggested by the late Sir William Halcrow, the banks are reasonably parallel, the alluvial deposits are thinner than elsewhere in the gorge and, in times of low water, a natural rocky beach became exposed on the left bank; this beach was particularly significant in respect of the choice of site because it was well suited to the construction of the first coffer dam and the excavation of the main diversion channel.

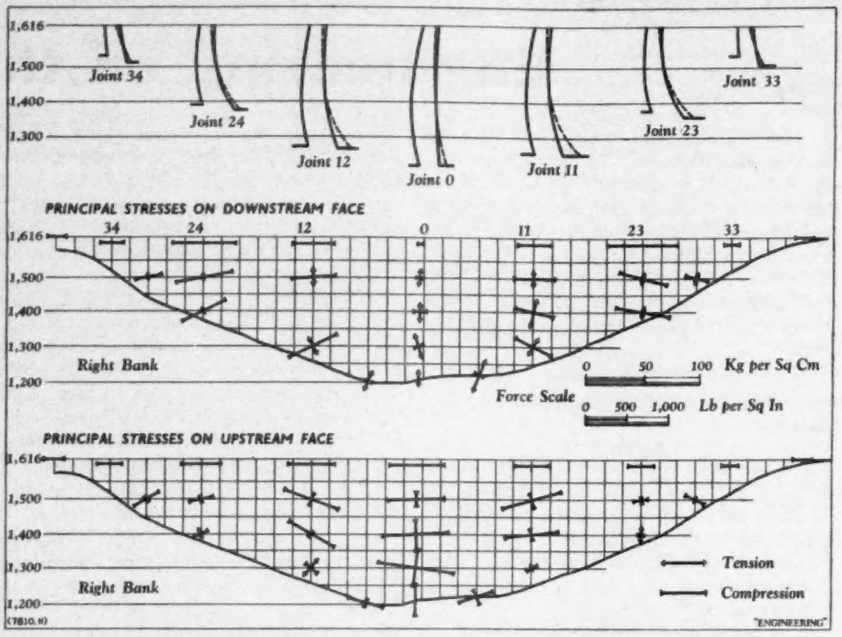
The gniess—a coarse folliated rock—contains veins of quartz and, at the surface, is well weathered. The main rock strata lie only a few feet below the river bed and outcrops of these strata are to be found higher up on the river banks. For the most part, the gneiss is hard and compact. At the op of the right bank above the dam site, there is a mass of quartzite which is heavily cracked and a number of falls were experienced at this point while blasting was in progress for road works and the blondin platform.

The dam is a double curvature arch design in mass concrete. This form of construction was chosen as being the most economical and the one that could be built most quickly. The wall has a maximum thickness at its base of 80 ft, compared with the 280 ft required by a gravity dam for the site. It contains 1,275,000 cu. yd of concrete which, over the contract period of 3½ years, has meant that an average of 55,000 cu. yd has had to be placed every month. After the floods of 1958, when the schedules were put back by three months, this rate was raised to 100,000 cu. yd per month.

MINIMUM VOLUME

The arch has a double curvature which, under conditions of a uniform stress, calls for a minimum volume of concrete. The first analysis of the preliminary design was carried out using relaxation methods but the final shape was decided upon only after a series of tests on models made to a scale of 1 in 400 (that is, the model had a height of only a little over 1 ft). The hydraulic loading of the model was simulated using mercury for fluid behind the arch. The major effect of the model analysis was to show that the preliminary sections were unnecessarily heavy near to ground levels but required strengthening just below the crest. From the final model it would seem that the highest compressive stress occurs on vertical planes spread uniformly over a large area of the up-stream face and is of the order of 800 lb per sq. in. A second series of model tests was also made to prove the proposed order of construction and it was on the basis of these tests that the heights and location of the cofferdams and other primary works were decided.

Six flood gates have been provided in the arch. Originally there were only to be four gates, but after the phenomenal floods of 1958 this was stepped up to six. Each gate is 31 ft deep by 30 ft wide and, under the maximum head of 105 ft, they will have a combined discharge of 336,000 cusecs. With the aid of hydraulic tests the lip of the cill has been so designed as to throw the discharge nearly 300 ft clear of the dam, thereby eliminating any risk of erosion at the foot of the wall. These caterpillar flood gates, and also the radial gates for the main intakes, were all made by Neyrpic-France of Grenoble, who obtained this work in the face of international tenders. Neyrpic also built and installed the screen rakes and their gantries.

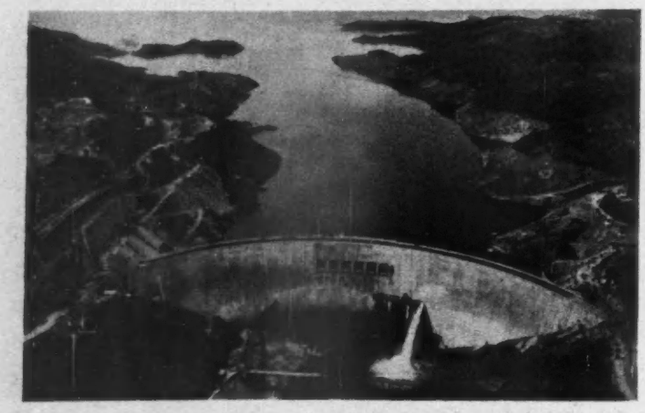


Stresses in the downstream and upstream faces as measured on a model.

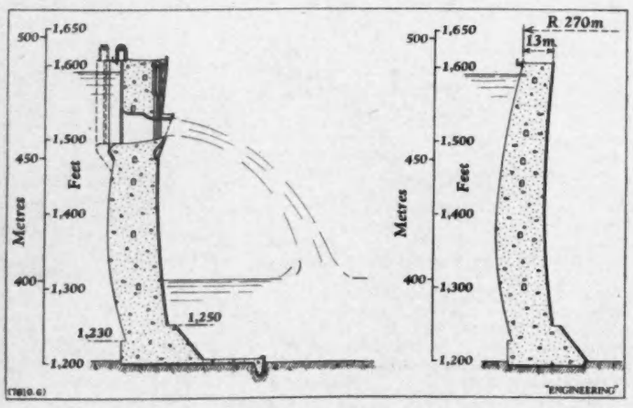
WATER INTAKES

The main intakes for the first six turbines are located in pairs behind the southern flank of the dam. As is shown on page 657 there is a pair of temperary low level intakes at an invert level of 1,370 ft for turbines 1 and 2 that have enabled the machines to be brought into use as soon as they could be commissioned. At 1,460 ft there are the intakes for turbines 3 and 4, also located so that they can be commissioned before normal top water level is reached. The permanent intakes 1 and 2, and for turbines 5 and 6, are situated at a level of 1,510 ft. The minimum retention level, which should be obtained during the rainy season of 1961-62, is at 1,560 ft and the maximum retention level is 1,590 ft; the maximum flood storage level is 15 ft higher at 1,605 ft. At May, 1960, with this year's rainy season gone, the water level in the reservoir is 1,490 ft.

All the intakes have apertures that are 54 ft by 32 ft measured at the sloping face of the gorge, where they are fitted with trash racks or screens. Away from the portals the intakes contract to



Aerial view of downstream face.



Cross-sections through flood gates and on centre line.

horizontal penstocks 16 ft wide and 20 ft high. The maximum intake by each machine is 4,800 cusecs, which corresponds to a velocity of 15 ft per sec in the horizontal penstock.

During the design of the intakes two model investigations were carried out for Sir Alexander Gibb and Partners at the Harlow laboratory of the British Hydromechanics Research Association. The first of these tests was made on a 1/200 scale model of the intakes and part of the dam and reservoir to determine the possiblity of air-entraining vortices being formed in the water above the intakes, and to experiment with means for eliminating them should critical conditions arise. The second investigation used a 1/20 scale model of one intake, from the intake screen, along the horizontal section of the penstock, passed the sector gate, and down the vertical section as far as the entry to the turbine scroll casing. Air was used as the working fluid as this enabled model volocities of 60 ft per sec to be reached so that Reynolds number for the model was high enough to avoid serious scale effects. This is a technique developed at Harlow that has many advantages both with respect to the equipment that is required and the ease with which measurements can be made. The tests enabled changes to be made so as to reduce the loss of head along the penstock and to improve the velocity distribution at the entrance to the turbine casing.

The vortex experiments suggest that, because the entry of the intakes is set parallel with the approaching flow, air-entrained vortices may well be formed under most operating conditions. There is the possibility, however, that the scale effects on the model have predominated and that the vortices will not materialise in practice. Whether or not they do occur is going to demonstrate the efficacy of such small scale tests when the prototype is so large. If, however, the vortices do form, the experiments showed that vertical baffles just above the intakes or floating rafts, while not eliminating the swirl at the intake, did prevent air entrainment. If necessary, the adoption of rafts will not prove difficult.

MAIN CONTRACT

The main civil engineering contract for the construction of the dam and the underground power house was awarded to a consortium of four Italian companies and their Rhodesian and South African subsidiaries, who formed a new company called Impresit Kariba (Pvt) Limited for the project. The value of the contract was £25·3 million. As already described, United Kingdom firms did much of the preliminary work before the main contract could be started. Cementation Limited and John Laing and Son (Rhodesia) Limited between them built the north bank coffer dam, the diversion tunnel and channel railway sidings, access roads and other works at a cost of £2·2 million, and Richard Costain (Southern Rhodesia) Limited built the townships at the site at a cost of £3·5 million.

Landing the contract was a triumph for Impresit. It had been formed only in 1930 and was owned by four Milanese companies, each holding equal shares; Impresa Umberto Girola, Impresa Ing. Lodigiani SpA, Dott. Ing. Giuseppe Torno and Company SpA, and Imprese Italiane All'Estreo SpA.

The award of the plum contract to a non-British company caused a storm of outraged indignation in Britain. Tempers quickly subsided and it was recognised that contracts are awarded "on prices, not excuses." It was disclosed that the next lowest tender to Impresit was £1,500,000 more, and the lowest British tender £2,000,000 more. As a Rhodesian paper commented, "an extra two millions for sentiment would have been a high price to pay."

Even the most sensitive British feelings were soothed by Impresit's own comment that 60 per cent of the £25 million contract would be spent in the Federation on equipment, wages, transport, cement, steel and taxes.

Prior to the construction of the dam itself blanket grouting of the foundations and the construction of the main cut-off curtain had to be undertaken. This work was sub-contracted by Impresit to the Cementation Company. It consisted of drilling and grouting from the rock surface either within the cofferdams or, as construction of the dam progressed, from the upstream scarcements. The curtain was generally 80 ft deep, but across the bed of the river, where a fault was discovered in the rock, it was taken down to a depth of 160 ft.

CONCRETE MIXES

From a construction point of view, the site is best understood from the plan on the next page showing the works area. The aggregate crushing, screening and washing plant, the sand bins, the cement silos and mixing plant were all installed on the hillside above the left bank and on the north side of the river. The principal sand stockpile and washing plant was located on the other side of the river because the sand was all obtained from the tributary further upstream on the right bank. After washing and screening the sand was transferred to the bins adjacent to the mixers by a cableway that had been erected in the early days of the work at Kariba. At one time, at the end of the low water season of 1957 and just prior to the main construction period for the dam wall, the sand stockpile was raised to 700,000 cu. yd, since the source was to be flooded by the impounded water of the reservoir.

The coarse aggregate was crushed in two stages, screened, washed and stockpiled in four separate sizes ranging from 8 in down to ¼ in. Cement, the equivalent of six million bags of it, was nearly all obtained from Chilanga Cement Limited at Lusaka in the Southern Rhodesian coalfields. It was transported to the site mainly in bulk, but also partly in bags. Storage at the site comprised 24,000 short tons in 80 silos and 4,000 tons in sheds, which together were sufficient to enable the peak consumption to exceed the maximum rate of delivery when necessary.

The main concrete batching and mixing plant was able to maintain an hourly production of 360 cu. yd an hour and this was supplemented by a secondary plant on the south bank that was able to contribute 80 cu. yd an hour. Both plants were equipped to produce any mix required on the site. The concrete was placed in the dam by three blondins which traversed the site and could each handle an 8 cu. yd bucket. High bucket speeds were essential to meet the required speed of construction and the travelling speed on the blondins was 15 ft per second and the vertical bucket speed 4½ ft per second.

Temperatures on the wall frequently exceeded 110° F in the shade and refrigeration plant having a cooling capacity of 10,500,000 Btu per hour was installed so that cooling water could be pumped through pipes embedded in the dam.

Three main grades of concrete were made for the dam. In the lowest blocks the cement content was 380 lb per cu. yd of concrete; this was reduced to 330 lb per cu. yd in the mid-height and top blocks of the wall. A higher grade concrete, containing 430 lb per cu. yd, was used for the upstream face of the wall, the spillway and some other exposed faces. Formwork for the dam, and also for the machine hall, was supplied to Impresit by Acrow (Engineers) Limited of London.

The arch length of the dam is divided by vertical radial joints at a spacing of roughly 50 ft, and each vertical joint divided into sections corresponding to the levels of the drainage galleries which run the length of the wall. Each section has been isolated on all sides by metal strips forming a complete flexible seal in mild steel and two copper strips near to the upstream face of the dam. The faces of the concrete in the joints were left grooved and these grooves were served by flow-and-return pipes embedded in the concrete; one of these piping systems was provided with rubber valves. As the concrete cooled and shrank, the joints were grouted before the water level rose. Later the joints were regrouted through the second (valved) system, and if necessary the process can be repeated in the future.

The Big Rush to Get the Main Work Started

Kariba was a thinly populated area devoid of roads. Major roads had to be laid and townships built to accommodate nearly 10,000 people. A first class airport was constructed. A diversion channel and tunnel were cut for the river and a coffer dam built to protect the first major workings.

THE first contractor to reach Kariba was the Rhodesian branch of the Cementation Company (Africa) (Pty.) Limited who, in December, 1951, were awarded a contract by the Government of Southern Rhodesia for exploratory drilling of three sites for the proposed dam.

The only access to the sites at that time was by tracks used by game rangers and hunters. Innumerable tributaries of the Zambesi cut across the tracks making them impassable in the rainy season. Since there were not direct paths leading from one potential site to the next all the gear had to be moved along the river using steel boats powered by outboard motors. Steel boats were used because of the risk of puncturing the hull on submerged rocks. The drilling rig was similarly mounted on a steel pontoon. Initially there were only half a dozen Europeans on the site living in pole and dagga huts but the encampment soon grew to 35 Europeans and 350 Africans. Rhinoceros, buffalo, elephant and other game abounded in the area. Any accident case had to be taken 55 miles along the track to the main road and then another 50 miles to Karoi for medical attention. Bilharzia, malaria and blackwater fever were a constant threat to the first men at the site. The thermometer read 100° F in the shade.

Of the three sites, that known as Site X was finally chosen as the location of the dam.

The decision to go ahead at Kariba, rather than at Kafue, was confirmed by the report of M. Coyne in May, 1955. So urgent was the need for more power in the copper belt that the Federal Hydro-electric Board considered it essential that work on the preliminaries should be begun without delay to take advantage of the dry period before the rains started in December. The contract for preliminary works was awarded in June, 1955, to the Cementation Company Limited.

PREPARATION FOR THE DAM

This contract, valued at £1,600,000, covered the diversion tunnel, the diversion channel, the north (left) bank cofferdam foundations, and certain of the site roads. The first air landing strip was prepared and was in use early in September, 1955. A five-ton cableway was

Continued on next page

erected across the river and a new suspension bridge constructed, Dorman Long (Africa) Limited being the contractors for the steelwork. The nearest traffic bridge had been at Chirundu, 40 miles down stream to the confluence with the River Kafue.

Camps were established to house the 250 Europeans and 4,000 Africans who were required during the first stages of the work.

In the next twelve months up to July, 1956, the diversion tunnel was driven through the southern right bank; it was 33 ft by 40 ft in section and 1,300 ft long and, except for breaking out the stop ends, was completed when the main contractor reached the site in August, 1956. The 900 ft long diversion channel on the left bank was also completed by then, having involved the excavation of 100,000 cu. yd of rock. The site, described in detail elswhere, is at a point where a rocky beach is exposed on the left bank during the dry season; it was through this beach that the channel was cut and the first cofferdam built.

Cementation also obtained a sub-contract for drilling and grouting the main dam cut-off curtain and contact treatment, the intake grout curtain, and joint grouting of all the underground structures. This work is referred to when describing the main dam contract.

ROAD AND RAIL ACCESS

Contracts awarded to the Laing group covered opening-up operations over 15 square miles of very rough country, much of which had to be surveyed on foot to inspect possible road routes, camp sites, and to search for natural sands, gravel and quarry sites. In this work the contractor worked especially closely with the local Southern Rhodesia Government division of irrigation, who played a particularly large part in constructing the southern access road.

Development of access roads began in July, 1955, and eventually some 128 miles of 25 ft wide roads were constructed. This work included the construction of 24 miles of Federal road to international standards (including all culverts and drainage work) over a contract period of twelve months. Time was the essence of the contract and the first 14 miles—a priority section feeding the south bank—was completed five months under the consulting engineers' original estimate.

To bring rail transport as near to Kariba as possible, the Federal Power Board decided that a railhead should be built at Lion's Den, in Southern Rhodesia, 144 miles away from the dam site and that similar marshalling facilities should be provided at Kafue, in Northern Rhodesia, 91 miles away and the nearest point at which the existing main line to the north could be intercepted. (The import of much of the heavy plant was through the port of Beira in Mozambique and then by rail to Lion's Den; from there road was the only means of transport.)

Both contracts were awarded to John Laing and Son (Rhodesia) Limited. The layouts at each site included one mile of access road, one mile of rail track, hardstandings, loading bay platforms, steel framed sheds, concrete foundations for weighbridges, electrically operated capstans, drains and ancillary works.

Many difficulties had to be overcome. The Kafue site was under approximately one foot of water. African labour was exceptionally difficult to obtain at Lion's Den, and the major force had to be imported from Nyasaland. Concrete aggregate was at a premium, but a good rock of a dolomite series was located within half a mile of the site and a quarry developed. The resulting concrete gave satisfactory strength tests and a good finish.

Air traffic was increasing and the temporary airstrip originally constructed was due to be submerged as soon as impounding of water began. The company was awarded the contract for the construction of a class "E" airport having a 4,500 ft long runway and modern terminal and transmitter buildings. Time was a most important factor and the contract was completed in 9½ months—slightly ahead of schedule. This airport lies on higher ground ten miles from the dam site.

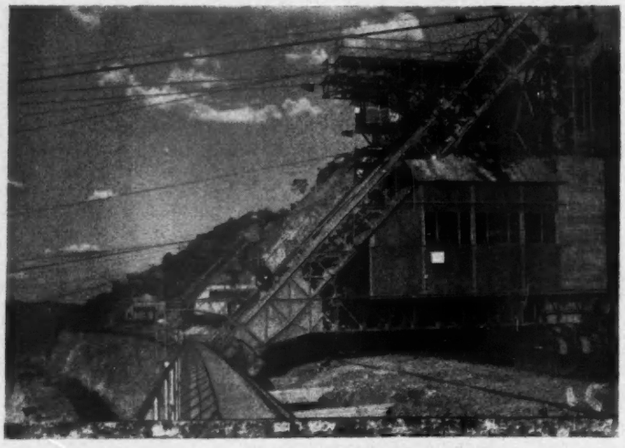
LIVING ACCOMMODATION

Simultaneously work was going ahead to establish the towns of Kariba to provide housing and amenities for the peak labour force of 10,000. The contract for the townships was awarded to Richard Costain (Southern Rhodesia) Limited in March 1956. Three months were taken up finding a quarry and sand, establishing a factory for making sand-cement blocks and building more temporary housing. In September 1957, the contract was complete, six months ahead of schedule.

The speed with which the work was accomplished can be largely attributed to the preliminary survey made at the site in advance of the tenders being advertised. Heavy plant that would be required for the task was not available in the country and it was recognised that there would not be time to get it after the contract had been awarded. A gamble was taken and the necessary plant—£250,000 worth—bought in advance.

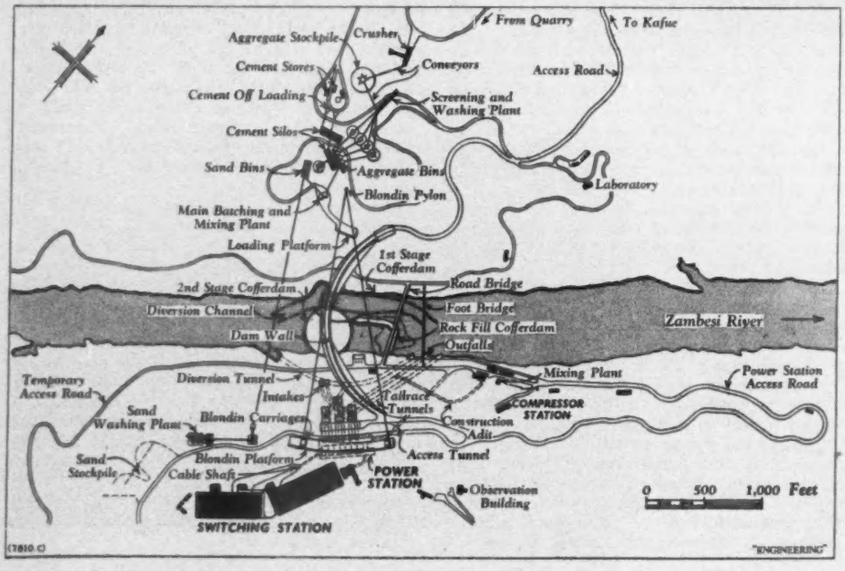
At the sites of the townships above the south bank surveying was begun, roads and foundations were marked out. A joinery shop, blockyard and quarry were established. The blockyard was put down by the river, not because the site was suitable, but because that was the only source of water. A purifying plant was set up for domestic water. Sand, obtained six miles away from a Zambesi tributary—the Sanyati—had to be stockpiled during the dry season while it could be obtained easily from the river bed, and before work on the main dam made heavy demands on the supply.

The build-up of labour on this housing contract was very fast. Within 2½ months there were 1,350 Africans and 200 Europeans on the job. The peak was reached in six months, followed by a rapid decline, the back of the contract broken and work in a second hot season avoided.



(Right) Blondin for delivering concrete to the dam under construction.

(Below) Site plan showing arrangement of main works area.



TOWNSHIPS TODAY

The European township occupies about 130 acres on one of the highest ridges overlooking the Zambesi, 2¼ miles from the dam. There are 250 family houses and 300 bachelor dwellings in two-storey blocks with 20 rooms to a block, as well as reception and administrative offices, kitchens and canteen, a swimming pool, power station, police lines, school, post office and banks.

The African township, on a slightly lower elevation, is only a mile from the dam site. Blocks of rooms are allotted in one, two or three room units to house the 7,000 African workers, many of whom have been trained in skilled jobs as the work progressed. Amenities include a canteen, beer hall, theatre, reception centre, church and clinic.

The fully equipped 90-bed hospital, with two doctors and a surgical specialist, the post office and banks are placed on a convenient site and cater for both races. Nearby is the Native Commissioner's office, labour department, police post and fire station. Water is pumped from the Zambesi and a purified supply made available for both the European and African housing areas, both of which are served with waterborne sewerage systems.

Even for temporary buildings the pace of

construction was rapid and many records were established and broken during the building of the township. Urgently needed bank premises were completed in nine days from excavation to painting, including the installation of plumbing and electrical works. One section put up the airport terminal building in ten days, working day and night, the painting and finishing on the last night being speeded up by an army of volunteers ranging from office staff to bulldozer drivers.

Today, Kariba, with over 7,000 residents, is one of the 15 most highly populated areas in the Federation. Neat, airy cottages built of concrete blocks with asbestos or corrugated iron roofs, painted in pastel shades, and with well-tended gardens, look out from the forested slopes over the rugged sugar loaf landscape of Southern Rhodesia.

From the suburbs of Aerial Hill, Boulder Ridge and Hospital Hill, residents can make use of the regular bus service to the shopping centres, churches or banks. Airmail postal service and an automatic telephone exchange were among the earliest amenities provided. Fresh milk supplies come by air and road from Salisbury, 200 miles away, while a low cost passenger air service is operated by African Airways Hunting Clan.

Mosquito and tsetse control by the Government has helped to keep the health of the workers remarkably good. With its model town and lakeside setting, the area could well become a popular tourist and holiday centre, with homes already built to house the government officers and the permanent staff retained on the Kariba Dam.

In addition to building the township, including its roads, Costains were awarded several sub-contracts for other roads around the site and also for heavy earthmoving and excavation works. These were carried out between 1956 and 1958.

One such contract was for a main access road down to the dam site on the south bank of the river and for a similar link road on the north bank. These two roads were to connect with the new suspension bridge then being built by Cementation and Dorman Long.

On the north side the road was extended to link with the main crushing and mixing plant for the dam wall. Another road lead from the quarry to the crushing plant. It had to be built to take fully loaded 22 ton Euclid trucks at the rate of one very eight minutes throughout a 24 hour day. Altogether 1¼ million cu. yd of raw stone were carried along that road for the dam.

Costains were also responsible for cutting the traverse path for the three blondin cableways when the main contractor installed to span the main dam. The cut was about 900 ft long, 100 ft wide and slightly radial in plan; at the centre it was 160 ft deep. The rock spoil was hauled six miles and used for the base course of a new road leading to the sandpits that had been established by the Sanyati river and from where all the sand for all the work was obtained.

Another considerable excavation was for the site of the switching station, which involved cutting the tops off hills and filling and compacting in between. The switching station, standing directly above the gorge, now commands a magnificent view of the dam and the rising lake.

Fissured rock—quartzite deposit—was one of the more serious problems that had to be met in this area, and on one occasion a slip occurred involving several thousand cubic yards of rock. At one point three excavation sites were being worked simultaneously one above the other: at the foot was the cut for the intake operating platforms, above that the south access road and above that the blondin platform. The combined height of the faces was nearly 300 ft. As all this rock had to be blasted, excavated and carted away while other work proceeded below, stringent safety regulations had to be imposed. At many points safety trenches were cut in the hillside below the main excavations while work on the dam was at a standstill. These trenches were to trap boulders that might be dislodged and to catch flyrock after blasting.

Costain staff, the heavy plant operators and fitters were all European while the drivers and labourers were African. At the peak of the road contract there were about 80 Europeans and 600 Africans. Plant employed included a dozen Caterpillar tractors, six mechanical shovels, a fleet of lorries ranging from 6 to 22 tons capacity and three road graders.

In Spite of Floods the Dam was Early

Construction work was undertaken in three phases based on the periods of low water in the Zambesi. Twice the work was swamped by floods of unprecedented size. In 1958 the flow was nearly twice any figure recorded previously.

THE programme of works is best described in a series of phases illustrated by the diagrams below. The order of works was as originally planned and was hardly altered even by the floods of 1957 and 1958, though construction rates had to be speeded up to meet the completion date.

Work began in the low water season of 1955 and 1956 with the construction on the exposed rocky beach of the thin circular cofferdam of concrete, 585 ft in diameter, designed to enclose the north or left bank of the main dam while still allowing the river to flow through its natural deep water channel. Simultaneously the diversion channel was excavated through the area of the coffer dam; this channel, kept dry by the cofferdam, was laid in preparation for the second phase of the work.

Also during the low water seasons of 1955 and 1956, and as part of phase 1, the diversion tunnel was driven through the rock on the southern bank. This tunnel, 1,300 ft long, 40 ft high and 33 ft wide, was left blind at the upstream end. Although no damage was incurred, the plug was blown out before it was intended and as a result the tunnel flooded prematurely.

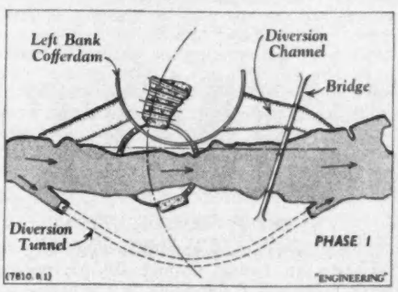
During the high water season of 1956-7 the flanking sections of the main wall were built. The right flank was built above the flood level of the river while the left flank was built within the protection of the cofferdam. This section of the main wall was built with four temporary passages, each 25 ft wide and 88 ft high across the line of the diversion channel. These passages were designed to by-pass part of the river flow during the next stage of the work.

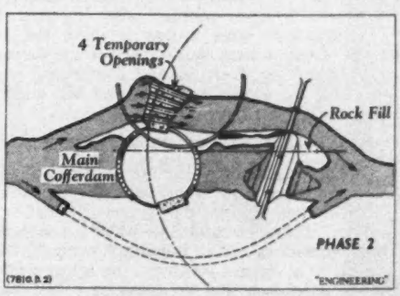
1957 FLOOD

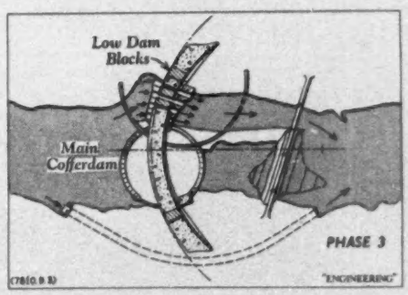
The work described above, phase 1, was all completed by December, 1956. Then in mid-March, 1957, there occurred the first of the two floods that were to so hamper work that at one time construction was six months behind schedule. The discharge rose to 300,000 cusecs and flooded the left bank cofferdam, though fortunately without doing any significant damage. The magnitude and timing of the 1957 flood is compared with the maximum discharges recorded between 1947 and 1956 and with the even greater flood of 1958 in the graph on the next page.

Work on phase 2 began as the river fell during May and June, of 1957. The cofferdam was demolished in July, 1957, where it crosses the diversion channel so allowing part of the flow through the temporary passages left in the completed wall. Using the road bridge just downstream to work from, the rockfill dam was tipped across the main river channel. This rockfill had the effect of stilling the water in the main channel and forcing the flow through the diver-

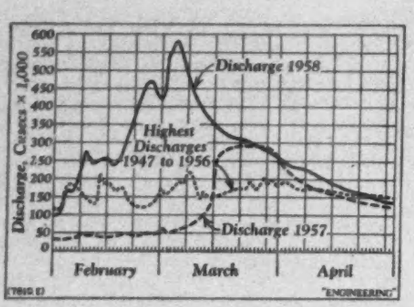
Before the flood in 1958.







The three main phases in constructing the dam across the Zambesi.



Discharge rates during the 1957 and 1958 floods.

sion channel and the now open diversion tunnel on the right bank. It was then possible to construct the main cofferdam, across the low-water bed of the river and around the site of the central section of the main wall.

Work on the main coffer dam started in July, 1957. First rock fill was dumped downstream of the works and the walls of the cofferdam were built in stilled waters up to a level that should have been adequate to ensure the protection of the river bed workings during the high water season of 1957-8; the walls were also extended until they butted against the constructed portions of the main dam on either side of the river. This completed phase 2 of the work.

1958 FLOOD

Phase 3 of the work covered the construction of the dam, first within the confines of the cofferdam and then as the wall was raised to its finished height.

It was during the first part of phase 3 that the great flood of March, 1958, occurred. The discharge peaked to 570,000 cusecs, compared to about half this figure that had been the highest recorded between 1947 and 1956 and the 300,000 cusecs of the previous year. During February the waters rose fast, first washing away the old road bridge (so that vehicles and equipment as well as concrete had to cross the river on the blondin) and then flooding the original airstrip. Reports from the upper reaches of the river and all its tributaries indicated that more floods were coming and work was concentrated on increasing the up-stream height of the coffer dam. Then during a lull in the flood the foundations of the cofferdam were pierced. The works were flooded within an hour. In the next ten days the river rose to the point where it topped the cofferdam and most of the completed works and swept away the suspension bridge downstream of the dam. Nevertheless, work in the underground turbine house was able to proceed except for a shut down of ten days when the three access tunnels had to be temporarily closed with bulkheads to prevent the flood entering the workings. Apart from this ten days the work proceeded underground without difficulty during the remainder of the flood.

It was not until mid-April that the river fell sufficiently for the cofferdam to be repaired and pumped dry again. Work was resumed on the dam and the schedules recast in an effort to make good the lost time.

By December 1958 construction was so far advanced that the average height of the wall was 350 ft above the river bed and sealing of the dam—"Operation Mousetrap"—was completed. Of the four temporary passages that had been left in the left flank of the dam, two were blocked in November. Final sealing was delayed until the discharge reached the agreed figure of 17,500 cusecs. Steel grids were dropped over the four openings followed by hundreds of tons of rock and blinding. A temporary setback occurred when one of the sealed passages sprang a leak but in time this was brought under control and work went on apace as the reservoir began to fill behind the dam.

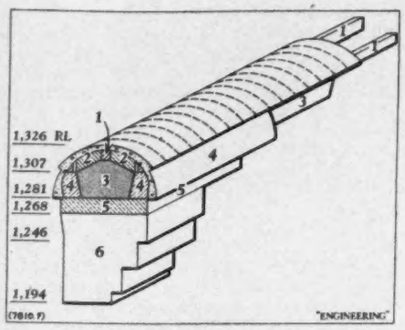
The dam itself was completed in June 1958, some ten months ahead of schedule.

MACHINE HALL

Simultaneously with the construction of the dam, work proceeded on the underground machine hall for the turbines and generators, the intake shafts, the busbar galleries leading to the transformer hall and the cableways up to the control buildings and switching station built on the surface above the machine hall. The location of these works is shown in the drawings on pages 654 and 657. The machine hall's overall dimensions are 468 ft long, 75 ft wide and 132 ft high and it will finally contain the six 140,000 h.p. Boving turbines and their AEI 100 MW generators.

The order of working when excavating the machine hall was as follows. The access tunnel from the ground surface was driven down to the loading bay on a falling gradient (1 in 7). After opening up the working face in depth the excavation was advanced as shown in the picture above right.

First the longitudinal tunnels (1) were driven along the whole length of the roof. The roof was then broken out between these tunnels and the first stage vault (2) concreted. Excavation was then continued downwards to the base of the vault (3). The second stage vault was then excavated sideways (4) and concreted. Excavation was finally taken downwards (5) and (6) to the foundation level of the turbines. Here the work joined up with the excavations for the



Order of excavating the underground turbo-generator hall.

vertical shafts of the penstocks (which are steel lined) and the draft tubes, surge chambers and the tail race tunnels. There are three tail race tunnels, each with an equivalent diameter of 34 ft and a length of about 950 ft.

As is detailed later, the order of construction within the excavated machine hall was determined by the plant requirements. First the draft tubes had to be erected and then concreted; this was followed by the installation of the turbine scroll casings which, in turn, had to be concreted and the concrete taken up to the foundations of the generators. Work is complete on sets 1 and 2, well advanced on set 3; concreting is in progress around the scroll casing of set 4.

The whole of the power station and ancillary works at Kariba are well below water level, the loading bay of the machine hall being about 400 ft below final top water level. It will therefore be realised that the grouting of the rock surrounding these structures was essential. In the machine hall, grouting was carried out from mobile gantries running on the wall beams put in for the 200 ton overhead cranes. For grouting of the south, or upstream, end wall of the machine hall, 10,000 ft of scaffolding were erected.

Other structures treated by grouting in Cementation's contract were the transformer hall, the draft tube outlets, the gate erection chambers, the main access gallery, the surge chambers, the cable shaft and temporary and permanent intakes and penstocks. In addition, the diversion tunnel plug, approximately 40 ft in diameter, was treated by four stage grouting.

Across the river, on the north bank, work is going ahead on exploratory borings for station "B" which will probably contain turbo-generator sets with a combined capacity of 900 MW.

140,000 h.p. Turbine, 720 ton Generator

The first power station at Kariba contains six 100 MW sets. Model tests were used to check the hydraulic conditions in the penstocks and the turbine casings. The generators—of the "umbrella" type—are among the largest of their type in the world.

MAIN contracts for the mechanical and electrical plant for the first stage of the scheme were let, almost in their entirety, to British firms. The six water turbines have been made by Boving Limited; the generators and equipment for three of the 330 kV substations by Associated Electrical Industries Limited; the 330 kV linking cables from the transformer room to the switch yard above by British Insulated Callender's Cables Limited; and Ferranti Limited received what was, at the time, the largest contract ever to be placed in Britain for power transformers and the first ever for 330 kV 3-phase transformers from this country—these were for the main sub-stations.

The most important mechanical contract to go outside Great Britain was that awarded to Etablissement Neyrpic of Grenoble for the flood gates for the spillway and the intake radial gates and screens, as well as for all the associated lifting gantries. Neyrpic's associated company, Sorefame-Portugal, supplied and installed the 17 ft diameter steel linings forming the last stage of the intakes before the turbine casings. The consulting electrical and mechanical engineers for the project are Merz and McLellan of Newcastle upon Tyne.

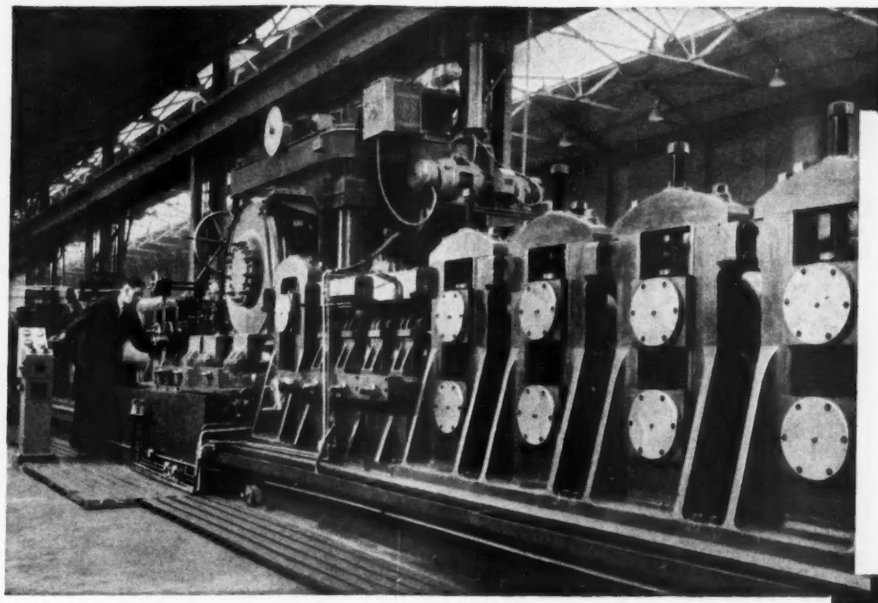
INTAKES AND PENSTOCKS

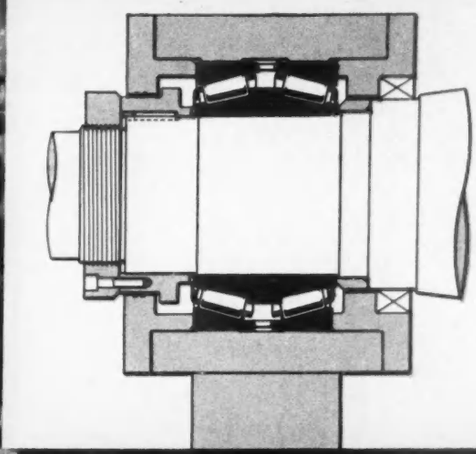
The arrangement of the power house is such that the waterways from the reservoir to the turbines are almost the shortest possible in length. From the intake the water for each turbine flows along a short horizontal concrete lined tunnel to a vertical penstock, the upper part of which is concrete and the lower part steel lined. A sector gate is fitted at the head of each penstock, as can be seen from the drawing opposite, and no inlet valves are fitted on the turbines.

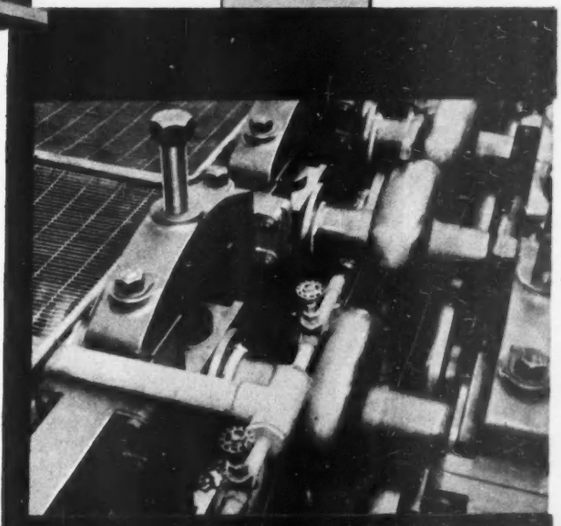
The experiments made at the laboratory of the British Hydromechanics Research Association enabled the shape of the upper bend to be designed so that the loss of head there is sufficiently low as to be a reasonable compromise between the economic requirements of the scheme and the best possible hydraulic arrangement. The velocity distribution leaving the lower bend and entering the turbine is what is to be expected with such an arrangement. It is possible that it could be improved by putting guide vanes into the bend but their presence would have introduced a complex design problem concerned with vane fluttering about which little is known. The relatively simple inlet was therefore accepted.

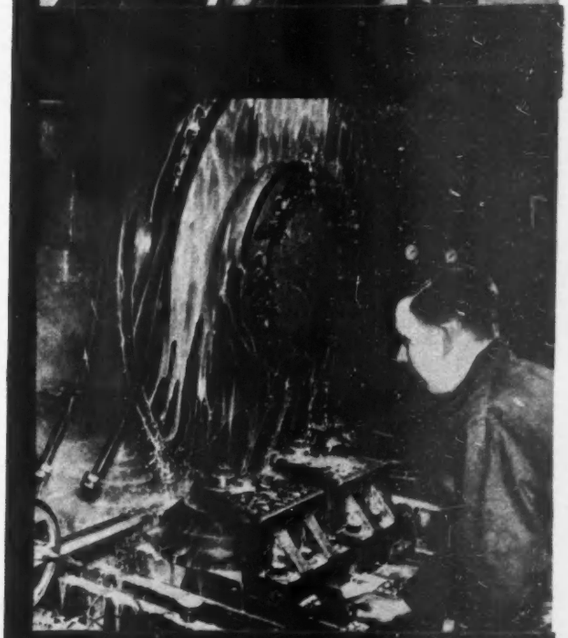
TURBINE CONSTRUCTION

From the penstock the water flows into the turbine spiral casing, through the stayring and guide vanes within the casing to the runner and thence through the draft tubes to one o the









On a mill producing large electric resistance welded mild steel tubes

This interesting plant at Tube Products Limited, capable of making Electric Resistance Welded mild steel tubes up to 5½″ diameter and over ¼″ thick, is the largest and most up-to-date E.R.W. mill in Europe.

The plant, made for continuous production, was designed and constructed by the firm's own engineering department.

Above can be seen the forming-roll unit equipped with Timken bearings, while on the right the partially-formed strip is seen passing between the horizontal forming-rolls running in Timken bearings, mounted as shown in the drawing.

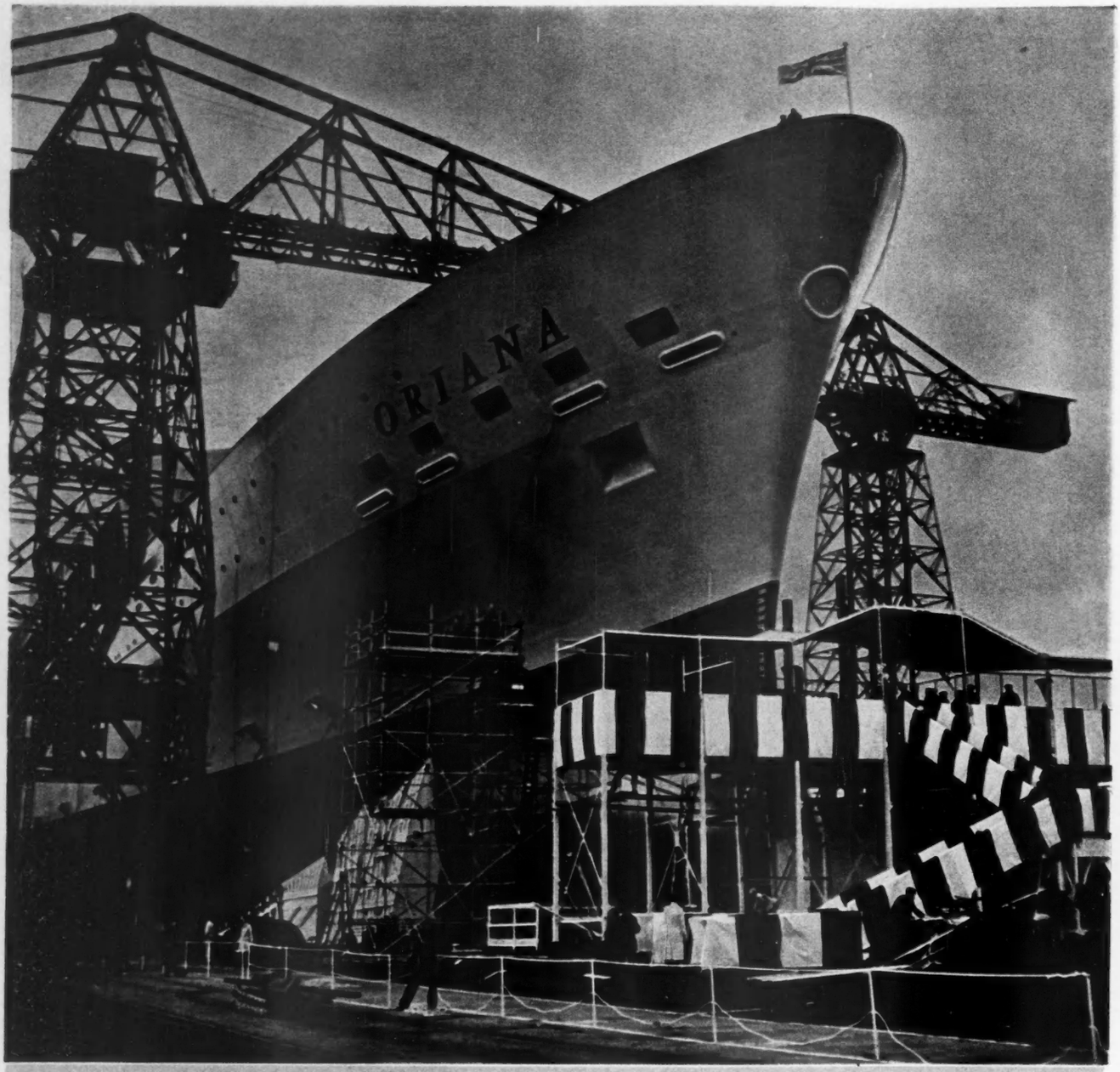
The lower view shows the welding stage of the E.R.W. process and here again the main spindle carrying the electrodes runs in Timken bearings.

British Timken, Duston, Northampton, Division of The Timken Roller Bearing Company. Timken bearings manufactured in England, Australia, Brazil, Canada, France and U.S.A.

TIMKEN®

REGISTERED TRADE-MARK

tapered roller bearings



FORGEMASTERS to the Marine Engineering Industry

The 'Oriana' built by Vickers-Armstrongs (Shipbuilders) Ltd. for the Orient Line, London, is intended for the United Kingdom-Australia route. Of 40,000 tons gross, her service speed will be 27½ knots, enabling her to make the journey in 3 weeks.

E S C are proud to have supplied the forgings for the main propulsion unit for the 'Oriana'. For many years E S C has been one of the world's largest manufacturers of forgings for the marine engineering industry.

A WHOLLY OWNED SUBSIDIARY OF ENGLISH STEEL CORPORATION LTD.

ESC

ENGLISH STEEL

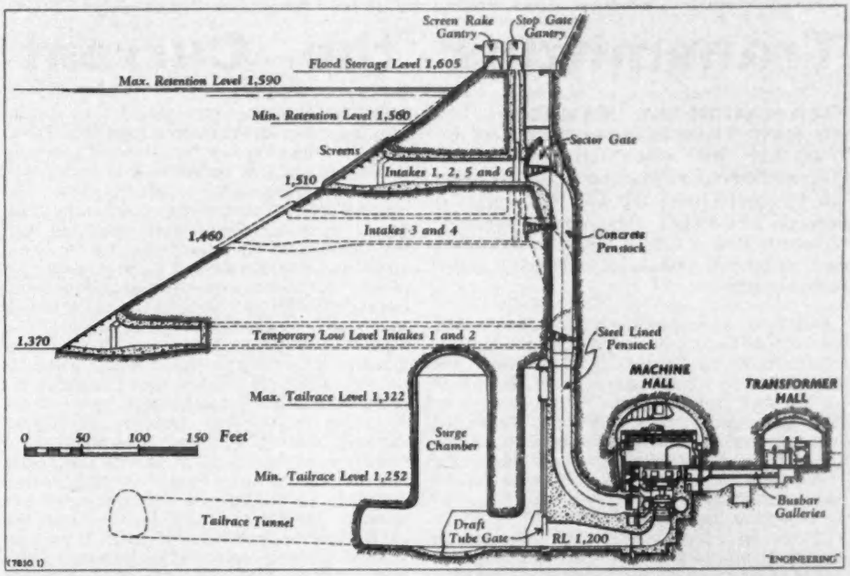
FORGE AND ENGINEERING CORPORATION LTD

River Don Works, Sheffield

three tailrace tunnels. Because of the length of these tunnels a surge chamber has been provided between the tailrace and the two draft tubes that it serves. The layout is exceptional in that the water enters and leaves the turbines on the same side of the power house, with the draft tubes located directly below the penstocks.

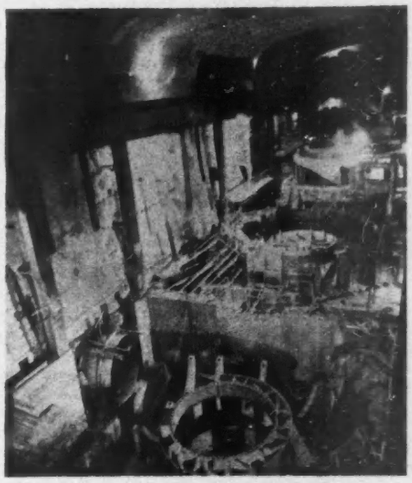
The turbines are vertical shaft Francis machines designed to produce 140,000 b.h.p. at a net head of 282 ft and to run at a speed of 167 r.p.m. They will operate efficiently both at the small heads that are to be expected when they are first commissioned up to the maximum possible of 352 ft; at this head they could generate 190,000 b.h.p. but the output will be limited to save overloading the generators. The largest dimension across the casing is 45 ft and the height from the bottom of the draft tube liner to the face of the coupling with the generator is 50 ft. Welded steel plate construction was used wherever possible in preference to castings. Shop manufacture of the machines was undertaken for Boving by Markham and Company Limited of Chesterfield.

The spiral casings were site welded from component sections up to 1¾ in thick and after the stayring had been fitted into place the assembly was pressure tested to 300 lb per sq. in. The concrete casing was then poured around the



(Above Section through the dam and the machine and transformer halls.

(Left) The dam under construction.



(Right) Machine (turbo-generator) hall which has been excavated underground.

steelwork after which the casing was welded to the penstock. Though this arrangement required special care to minimise locked up stresses between the two members, welding proved to be quicker and more economical than the riveting that had been considered originally for this connection.

The stayring comprises twelve cast steel stay vanes welded to heavy plates to which the casing plates are connected and which also support the top and bottom turbine covers. These stay vanes also transmit the weight of the generator to the concrete foundations.

After passing through the stayring the water enters the runner through 24 guide vanes, the angle of which is controlled to adjust the flow and hence the output of the turbine. Each vane, weighing nearly a ton, was made from a single pressing of steel plate and welded to forged steel trunnions that rotate in bronze-lined grease-lubricated bearings in the top and bottom covers.

The runner, weighing about 40 tons, has blades that are of stainless steel welded to a cast carbon steel hub and band; high chromium stainless steel electrodes were used and stainless steel protection was also applied to the runner band to eliminate danger of cavitation pitting. The design was tested by efficiency and cavitation tests on a one-sixth scale model of the turbine and draft tube. Carrying the runner is a shaft of 37 in diameter which is joined to the rotor of the generator by a flange coupling of 63 in diameter. The shaft runs in white-metal self-lubricating bearings. Helical grooves in the bearing shell and the rotation of the shaft together draw the oil up from a lower reservoir to which it returns by gravity. Circulating water ensures that the oil is kept cool. A carbon ring seal ensures that water cannot rise up the shaft, despite the high tail water head that can occur, but a gravity drain and pumps are provided to remove any seepage that there might be.

WATER CONTROL

Below the turbine there is the draft tube, simple in shape, steel lined as far as the downstream end of the bend and designed for efficient recovery of the velocity head. All six draft tubes had to be installed early in the construction of the turbine hall and they were made partly by Babcock and Wilcox, Vereeniging, and partly by Dorman Long in South Africa, possibly the first time that any major parts of really large water turbines were built in the Union.

The governor of each turbine comprises a speed-sensitive actuator of standard Boving design. Instructions to the actuator pendulum are magnified through relay and regulating valves and transmitted to the twin guide vane servomotors, which together exert a torque of over 600 tons-ft on the regulating ring; in turn, the regulating ring controls the angle of the guide vanes. Because of the shortness of the penstock, the vanes can be closed very quickly without an undue pressure rise in the penstock or turbine casing. The full flow of nearly 5,000 cusecs for each set (nearly two million gallons a minute) can be turned off in 3½ sec by closing the guide vanes.

Boving were also given the contract for the station drainage and turbine de-watering systems. The two systems are independent to ensure that no inadvertent flooding can occur by incorrect use of the valves.

Each of the turbine casings, draft tubes or tail race tunnels can be drained for inspection or maintenance.

The contracts with Boving—and the other equipment manufacturers—included not only design and manufacture of the machinery but also its transport and erection at Kariba. In the case of the turbines, all the components except the runners were broken down to permit transport by rail from the port of Beira, in Mozambique, to the rail head at Lion's Den, and thence by road. The runners, 13 ft 6 in in diameter and weighing 40 tons, were taken all the way by road from Beira on low loaders, a distance of 620 miles.

The erection programme for the turbines began at Kariba in 1958 and will continue until 1962 until the sixth set has been installed. Some of the complexities of the programme were due to the intermittent way in which the work could be tackled. After the draft tube liners had been welded and positioned, they were embedded in concrete and the turbine foundations built up to the level of the casings by the civil contractor. The turbine erectors then returned to instal the casings after which the work was handed back

Continued at foot of next page

Transmitting the Current from Kariba

Generation at Kariba is at 18 kV. This is stepped up to 330 kV in the underground transformer station. Current is then taken up to the switch yard located on the hillside above the dam. Distribution is at 330 kV to six major sub-stations

THE dam, with its underground power station, is the focal point of the Kariba project. But essential to the project as a whole is the transmission system that conveys the power to the load centres; to the industrial north of Kitwe and the copperbelt and, in the south, the large centres of population such as Salisbury and Bulawayo. As for the electrical and mechanical plant generally, the consulting engineers for the transmission system are Merz and McLellan of Newcastle upon Tyne.

From an administrative point of view the supply system in the Federation was simplified when the Federal Power Board was formed in 1956 with the authority to regulate an integrated system based on all electric power sources within the area, including the supply of current in bulk from Kariba; there are four principal thermal stations in the north and another three in the south, controlled by four local supply authorities, with a combined capacity of about 550 MW. The board, on extending its transmission system to form an inter-connection with any local authority, is enabled to direct the subsequent operation of the local generating stations.

The distances involved dictated a high voltage transmission system and, because of the cost of transformer stations to step down the voltage to the local distribution voltage, it was necessary to deliver power to the receiving areas in large blocks at a limited number of points. In the north Kitwe was already the centre of an existing 66 kV system and the receiving station for a 220 kV importing link from the Belgian Congo. Kitwe was therefore the natural receiving centre in the north for the new system. In the south, points of supply near to Salisbury and Bulawayo were obviously necessary, as was also one near to the large steam generating station at Umniati. The easterly connection in the south has been established at Norton, about 23 miles from Salisbury.

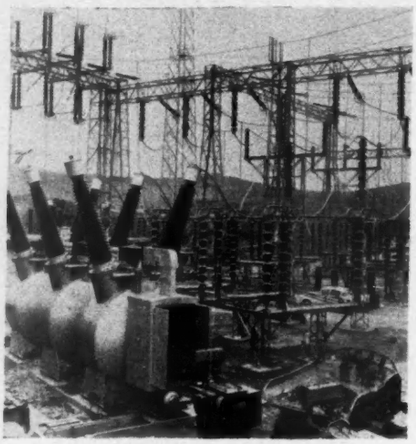
The location of these points of bulk supply argely defined the grid that had to be established. These centres and the resulting transmission lines are shown on the map on page 651. Provision for expansion has been made by making minor deviations in the route near such townships as Sinoia, Gwelo and Lusaka. The expected development of the system is indicated by the diagrams on the opposite page. Although the first stage of the project—Kariba "A"—will be finished in 1961, the last turbo-generator set in the "B" station is not expected to be commissioned until 1971 and development of the project as a whole will continue until then.

Before deciding to transmit at 330 kV, consideration was given to four schemes based on voltages of 220, 275, 330 and 380 kV. The choice of 330 kV was reached as a compromise between the initial and ultimate requirements of load carrying, security of supply, maintenance of stability, good lightning performance (the area is liable to exceptionally heavy electrical storms) and cost. On the last score, the initial cost was found to rise with the transmission voltage, but the final cost of the system to be less. The chosen voltage of 330 kV was selected because of ultimate financial advantage it offered over the two lower voltages; on the other hand, a limitation had to be placed on the initial capital outlay and for this reason it was also preferred to the 380 kV system.

In order to keep first costs as low as possible, supply to some centres has had to be provided over single circuits, with a consequent reduction of the security of supply as compared to a duplicated system. Nevertheless, it was essential to give a higher standard of security than that normally provided for single rural distributors at lower voltages. Faults on a 330 kV system are predominantly of the single-line-to-earth type, so any means adopted to reduce the chance of an outage due to such a fault would appreciably improve the security of the supply. For this reason single-pole automatic reclosure was used.

The main control centre of the Federal power has been set up at Sherwood, with manned subsidiary controls at Kariba itself, Kitwe, Norton, Salisbury and Marvel (for Bulawayo) substations. Communications between these control points will be by a combined voice-frequency telegraph and power-line carrier system; separate carrier-current equipment is employed for protective purposes.

As already described in a previous article in this supplement, the first generating station at Kariba will comprise six 100 MW machines generating at 18 kV. These turbo-generators



Switchgear for Kariba.

and their associated switchgear are located in the main machine hall while in an adjacent smaller hall, also underground, are located the principal step-up transformers, the 330 kV surge divertors and the shunt-compensating reactors with their switchgear. Connecting the generators to the transformers are the 18 kV busbar galleries. In the transformer hall there are ten English Electric 80 MVA single-phase transformers, arranged in three 240 MVA three phase banks (with one spare) to step up the voltage to the 330 kV used for transmission. One bank of transformers is connected to each pair of generators, and cooling is by water tapped from the penstocks.

The unusual route conditions from the underground transformer hall to the surface switch yard above controlled the design of the main 330 kV linking cables, the contract for which (plus auxiliary 11 kV and control cables) was placed with British Insulated Callender's Cables Limited. From the terminals of the transformers, the cables travel in sand-filled troughs through a horizontal tunnel for about 240 ft before rising up a vertical shaft to ground level, 540 ft above. Over the surface the remainder of the route is across steeply rising ground to terminate at the switch yard. For the last part of the run, the cables are set in chases concreted into the ground. In the shaft each cable is supported by cleats in a wave formation to minimise the effects of thermal movements.

330 kV GROUND CABLES

The specified cable current is 500 amperes at 330 kV (equivalent to 285 MVA for a three phase group). To meet this load a conductor area of 0·85 sq. in of copper has been provided. The cables, an oil filled type, comprise a central spiral steel duct surrounded by layers of copper wires to build up the required conductor area. Outside the conductor there are three metallised paper screening tapes, followed by insulating paper tapes to a wall thickness of 1·1 in (radial). The dielectric is finally screened by one metallised paper and one copper woven fabric tape. A lead alloy sheath, reinforced with tin-bronze tapes and armoured with hard drawn aluminium wires protects the dielectric and forms the pressure retaining wall of the cable.

At the bottom of the vertical shaft the hydrostatic pressure in the cables is between 250 and 300 lb per sq. in. To make the joint at the foot of the shaft the hanging cable was drained of oil, the connection made, and the cable then re-impregnated on site; tests showed the result to be in no way inferior to the original cable.

The sealing ends are the same at both ends of the cable route, using condenser cones with

---

Concluding **Turbine and Generator**

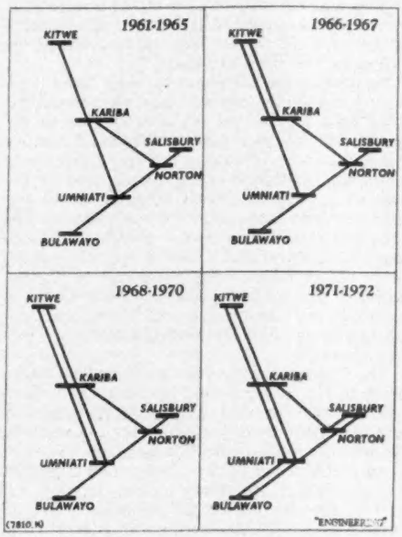
for concrete to be placed up to the level of the generator foundations. Possession then reverted to the turbine staff to fit the runner, guide vanes and basic control mechanisms.

"UMBRELLA" GENERATORS

Each of the generators, which are among the largest of their type in the world, weighs 720 tons and the stator core is 28 ft 7 in in diameter. The generators are of the umbrella type and are rated at 100 MW (111 MVA) 0·9 power factor lagging, 18 kV, three phase, 50 cycles, at a speed of 176·7 r.p.m. The vertical shaft is fitted with a thrust bearing and one guide bearing, positioned immediately below the rotor, which also serve for the turbine runner. This choice of machine type, with only one bearing below the rotor, was significant in that it enabled the height of the machine hall to be kept to a minimum. Excitation for the generator is provided by 364 kW d.c. machine working at 360 V, fitted to the generator and controlled by a rotating magnetic amplifier voltage regulator. Auxiliary equipment includes built-in fire fighting apparatus which is brought into operation by thermostats in the hot air circuit, a high pressure oil-operated system for jacking up the rotor, governor and bearing oil purification equipment, an air compressor for braking and the generator and transformer cooling water system.

The first generator was fully tested at the AEI works at Trafford Park, Manchester (illustration page 660). It is believed to be the largest generator ever subjected to a full over-speed test on a manufacturer's premises in this country. In addition to the test to 90 per cent rated MVA, the set was also subjected to three-phase instantaneous short circuit tests, from open circuit to full voltage. The tests were also notable because closed circuit television was used at Trafford Park for the continuous recording of oil levels and bearing temperatures.

Components from one of the Kariba machines was also used to study bearing oil movement. A large inverted U-shaped cylinder, representing a guide bearing journal, was used in conjunction with Perspex barriers to observe the behaviour of the oil in the guide bearing housing.



Development of the transmission system.

hand applied paper rolls in outdoor porcelains. The use of outdoor terminals in the transformer hall was dictated by the provision of surge divertors at the transformer terminals.

To meet the very severe lightning conditions to which the area is liable, the acceptance tests, in addition to normal insulation and mechanical tests, included an impulse test to 1½ million volts. Most of the tests were carried out on an installation consisting of two porcelains, a straight joint and about 30 yards of drained and re-impregnated cable to simulate site conditions. They included an a.c. voltage test of 475 kV(rms) for 15 minutes, two series of loading cycles at 1½ times the nominal working voltage, during which the cable was heated for 8 hours to a conductor temperature of 85° C and allowed to cool for 24 hours, and the impulse test of 1,500 kV peak consisting of ten positive followed by ten negative impulses at maximum cable temperature. After the acceptance test more impulses were applied until failure finally occurred at a peak voltage of 1,720 kV.

SUBSTATIONS

High up on the hillside, and providing perhaps the best view of the river, the dam and the rising reservoir, is the switch yard with the control building and the administrative offices. Two adjacent small hills, almost directly above the power station, were decapitated and levelled to form a stepped area sufficient to accommodate a 330 kV double-busbar station and with room to expand for the intended scope of the project, though only because a particularly compact switchgear layout was designed for the Kariba site. This compactness of electrical equipment pushed up the cost of the switchgear, but the savings obtained in the civil engineering work for building only a small yard more than offset the increase.

To reduce the area occupied by the switchgear the equipment uses vertical blade isolators instead of the horizontal blade type, so cutting down on bay width. The bay length has been cut by using a higher level than is usual for the busbars, bulk-oil circuit breakers with integral current transformers, and mounting the by-pass and one circuit isolator on the same structure, one upright and one inverted.

Though the value of a compact equipment was much less at the other substations, the Kariba layout was adopted throughout, so obtaining a uniformity of arrangements at all the substations.

Lightning protection of the substations is provided by masts 65 ft high superimposed on the structures that are themselves 72½ ft high. Exceptions are at Salisbury, where overhead wires were more convenient, and at Kariba itself where free-standing masts 200 ft high have been erected. This arrangement at Kariba eliminates all risk of a flashover where such a busbar fault would have particularly widespread effects.

Wherever possible the substations have been earthed in the conventional way by driven rods and copper bonding; where difficult conditions have been met, buried earthing meshes have been used.

The 330 kV switchgear for the whole of the project has been supplied by the Switchgear Division of Associated Electrical Industries Limited, principally from their Rugby works. The transformers for the substations have been built by Ferranti Limited of Hollinwood, Lancashire. Local transmission voltages vary with the areas served and included systems at 33, 66, and 88 kV, and the step-down transformers were designed accordingly. At Kitwe the arrangements have had to cope with both an existing 66 kV system and the 220 kV import line from the Belgian Congo which runs further north into copperbelt.

The first half of the switch yard at Kariba itself is complete, and so are the substations at Norton and Salisbury: other units have also been commissioned at Lusaka and Kitwe.

TRANSMISSION LINES

The largest contract on the electrical side was awarded to Rhodesia Power Lines (Pvt) Limited for the construction of the main 330 kV transmission lines. Altogether, the total length of these extra-high voltage lines, not taking into account any duplication, is 875 miles. The value of the contract is around £10 million. The successful contractor is of Italian origin and the low bid that was put in came partly from the low price asked for the supply and erection of the steel transmission towers.

Single-circuit lines with double shield wires have been adopted throughout the system. The choice of conductor was based on studies of the transmission capacity, resistance and corona losses, radio interference and cost. Two steel-cored aluminium (sca) conductors per phase, each of 0·35 copper equivalent cross-section, at 18 in spacing, was the economic choice. As the system is to supply the world's third largest copper producing area, the merits of copper conductors were considered: they were ruled out both on account of the cost of the copper and their weight which would have increased the cost of the towers and their foundations. The standard tension in the cables is 5,000 lb.

To withstand the possible power fluctuations under conditions of rain, the suspension insulators consist of single strings of 19 discs of 10 in diameter at 5¾ in centres. The insulator discs are mainly of Pilkington "Armourlight" toughened glass, but porcelain has also been used.

Conventional lattice-type towers, 115 ft high to the shield wires, and 74 ft 10 in out-to-out of the main conductors, have been used, though consideration was also given to the possibilities of portal frame towers. The standard spacing of the towers is 1,500 ft. Marginal strength in each suspension tower is sufficient to allow for the loss of tension in any one phase conductor to permit repair or replacement without guying (or the breakage of a conductor). To avoid the cost of concrete footings for the towers, the standard foundation is of the earth grillage type, with concrete blocks being used only where poor ground dictated their use.

To prevent the contamination of the insulators by large birds, all the towers have uncomfortable serrations bolted to the cross arms at strategic positions.

The High-Level Plan First

Economic and industrial expansion of the Federation of Rhodesia and Nyasaland demanded electric power. Despite the capital cost of £120 million, the cost of power per unit at Kariba will be among the lowest in the world.

ELECTRICITY is essential to the industrial expansion of the Federation of Rhodesia and Nyasaland. In the past the prosperity of the three territories making up the Federation—Northern and Southern Rhodesia and Nyasaland—has depended on their mineral deposits and the agricultural produce. The future requires the fuller exploitation of natural assets, supported by growing secondary industries.

The most important of the mineral resources are the vast deposits of copper ore in Northern Rhodesia. The working of these deposits is the basis of the country's economy now, and is likely to remain significant for many years to come. There are, however, many other mineral assets that are contributing to the Federation's income, or soon will be so doing: coal, lead, zinc, "new" metals such as vanadium, tungsten, beryllium and lithium, as well as petalite, mica, iron pyrites, fluorspar and limestone. A healthy agricultural industry is also expanding and a number of manufacturing concerns are flourishing, producing finished and semi-finished steel goods, cement, processed food and other products.

Further expansion depends on the provision of electric power. This, in turn, demands the installation of more generating capacity.

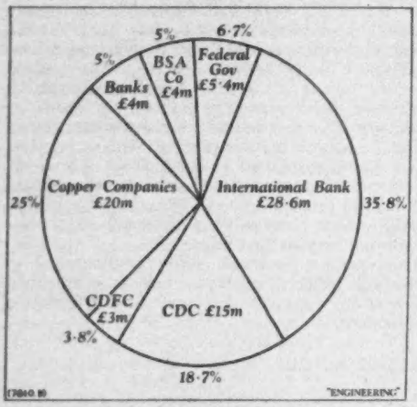
Such was the position when it was decided to construct a major hydro-electric project on the River Zambesi. The course of the river in relation to the location of the principal centres of industry and commerce—Kitwe and the copper belt in the north, and to the south Bulawayo and Salisbury—are shown on the map on page 651, which also shows the grid system that is being constructed.

Hitherto the area has depended on thermal stations for its electrical power. Coal deposits are extensive, though only at one centre—Wankie in Southern Rhodesia—has coal mining been developed, and this is remote from the considerable industrial centres of the northern territories. Much thought was given to the relative merits of hydroelectric power and conventional thermal stations before the choice could be made. Inevitably, the capital costs of installation are higher for hydroelectric stations than for thermal, and this was certainly true of works on the scale required on the Zambesi and its tributaries. On the other hand, fuel costs are high for thermal stations, whereas the running cost of a hydroelectric station is almost negligible. The location of hydroelectric works is severely limited to suitable sites which are usually found only in undeveloped and remote areas. Conversely, the thermal station can be located at choice to minimise the overall cost of transporting coal and transmitting the generated power to the user.

On the other hand, hydroelectric stations do not suffer from "obsolescence factor" as do thermal stations. Generally speaking, hydroelectric plant is as efficient as it ever can be, but the boilers of the thermal station are still being improved so that older thermal stations become progressively less economic in operation. Account must also be taken of the river control that is obtained with the construction of a dam. At the cost of flooding a large tract of land behind the dam it becomes possible to limit the water in time of flood and to increase the natural flow in dry periods, to the general benefit of the whole community, agricultural and industrial.

In 1954 the Government of the Federation (which had come into being in the previous year) decided that in the future the generation of electricity should depend on hydroelectric power. At that date current was being imported from the Congo and Portuguese East Africa, and a large proportion of the country's rolling stock was being used to transport coal to the existing power stations. It was believed that hydroelectric power would be cheaper than that generated at conventional thermal stations. Atomic power was considered but it was estimated that it could not be established economically in the Federation.

Even as early as 1925 schemes had been considered for the construction of hydroelectric power stations in Southern Rhodesia. In a comprehensive study by the Government hydrographic engineer an assessment was made of the power potential of sites at the Victoria Falls, in Kariba Gorge itself and also in Mapata Gorge. It was in 1937 that it was first suggested that a hydroelectric scheme in the Kariba Gorge



(*Left*) *Sources of finance for Kariba.*

would completely change the future economy of Northern and Southern Rhodesia.

KARIBA OR KAFUE

In 1946 a Hydroelectric Power Commission was established, with representatives from both the northern and southern territories.

The commission quickly concentrated its attention on two sites, that at Kariba on the Zambesi itself in Southern Rhodesia, and another on the River Kafue, a tributary of the Zambesi. This second site is roughly 90 miles to the north-west of Kariba and close to the main railway that runs from Livingstone through Lusaka to Kitwe and the copper belt. It is in Northern Rhodesia.

The choice between the two schemes became one of great controversy. There were the economic and technical arguments, but in addition the choice became a popular issue and a matter of intense regional pride. At first sight the Kafue scheme had much to recommend it. The River Kafue could be contained by a smaller dam, only 140 ft high, as compared with the 420 ft high wall required at Kariba. The potential outputs of the two projects were 380 MW and 1,500 MW respectively. Kafue had the advantage of being that 60 miles nearer the copper belt where the extra power was so urgently needed—transmission lines would be shorter and, being smaller, the Kafue scheme could be commissioned more quickly than that at Kariba. The capital cost of £23 million would have been more easily raised than the much larger sum for Kariba. In March 1954 the new Federal Government seemed to favour Kafue.

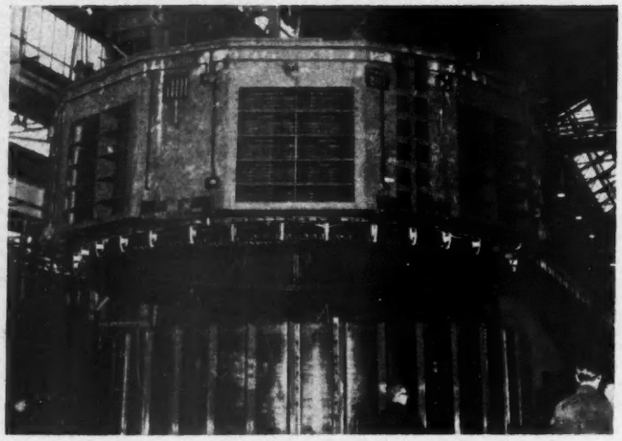
Further economic and engineering studies were instituted. An independent mission sponsored by Electricité de France investigated the two projects. Both were declared practicable. Further opinion was then obtained from M. André Coyne, the French consulting engineer and a world authority on arch dams. After a final appraisal, M. Coyne stated that both schemes were excellent but that in his opinion Kariba was the better. The Government had already stated that they favoured the Kariba scheme, subject to M. Coyne's being satisfied that the scheme was in fact practicable and that it was acceptable to the economic mission from the International Bank for Reconstruction and Development, from whom financial help would certainly be needed.

POTENTIAL OF KARIBA

The scheme that was envisaged at Kariba—and which has now come into being—required a dam 420 ft high and 2,025 ft long at the crest. Ultimately the dam will raise the level of the water 350 ft above the dry season level of the river, flooding the Gwembe Valley. The lake will be 175 miles long—reaching three-quarters of the way back to Livingstone and the Victoria Falls—and have a greatest width of 20 miles; the surface area will be 2,000 square miles. It will be fed by a catchment area of 200,000 square miles, an area approximately the same as France.

The ultimate generating capacity of Kariba will be 1,500 MW, twice that proposed for the Volta scheme in Ghana and ten times the full output of Owen Falls. The ultimate (in 1971) cost of power from the scheme is expected to be only 0·28*d* per unit at the main substations. The scheme is to be completed in two stages, the first with a power house on the south, or right bank, developing 600 MW, the second involving another but larger power house on the left bank. For station "A" on the right bank, the turbo-generator sets comprise six 140,000 h.p. water turbines coupled to 100 MW generators; the arrangement and capacity of the machines for station "B" has not yet been finally established. Complete, the project will produce over 8,000 million kWh a year, and the cost per unit—despite the capital charges of £120 million—will be among the lowest in the world.

(*Right*) *Assembling a generator for test in England.*



MEETING THE COST

The cost of Kariba was recalculated and it was found that for the first stage alone—the dam plus 600 MW of installed generating equipment—had risen to £80 million. The Government decided to proceed. In view of the copper belt's urgent need of power it was essential to take advantage of the low river flow (May to November) and to make an immediate start on the preliminary work at site.

The Hydroelectric Board met on 31 May, 1955. They appointed Gibb, Coyne, Sogei (Kariba) (Pvt) to be their civil engineering consultants. This consortium was formed in Rhodesia from the London firm of Sir Alexander Gibb and Partners and from the two French firms of MM. A. Coyne and J. Bellier and Société Géneral d'Exploitation Industrielles (Sogei). A month later the British firm of Merz and McLellan were appointed to be the mechanical and electrical consultants for the project.

Also at the May meeting a contract was negotiated for the work on site, exploratory drilling and the construction of the foundations for the first stage coffer dam. Preliminary notice was also given that tenders would be called for the main contracts.

Meanwhile the Government were faced with raising capital far beyond their own resources. They already had had an assurance from Sir Ernest Oppenheimer that the Rhodesian Anglo-American group of companies would give every assistance towards bringing the scheme to the generating stage as quickly as possible. It was not until June 1956—after the main tenders had been submitted—that the World Bank announced from Washington that it would lend £28 million to the Power Board towards the cost of Kariba. Another £15 million came from the Colonial Development Corporation and £3 million from the Commonwealth Development Finance Company Limited.

The Federal Government undertook to make loans to the Power Board totalling £28 million from monies borrowed from the Anglo-American and Rhodesian Selection Trust copper combines, the British South African Company, the Standard Bank and Barclays Bank. The sources of finance for the project are shown in the diagram. It will be seen that the copper companies who will benefit greatly by the scheme did a lot to help, though they will be by no means the only beneficiaries.

In July 1956 the main civil engineering contract was awarded to Impresit Kariba (Pvt) Limited, a company of Italian origin. That for the main transmission lines was won by Rhodesian Power Lines (Pvt) Limited of Salisbury. The main contracts were also placed for the turbines and the generators. Boving and Company Limited of London were to supply the water turbines and Associated Electrical Industries Limited, Heavy Plant Division of Manchester—the former Metropolitan-Vickers company—the generators.

Flooding nearly 2,000 square miles of territory cannot be undertaken without causing a major upheaval for the peoples of the area. Over 50,000 people have been, or will be, forced from their traditional homes as the reservoir fills. Great efforts were also made to see that wild life was not destroyed unnecessarily and some of the rarer strains lost for ever; "Operation Noah" was the popular name given to the great exercise that was put in hand to save wild life.

The reservoir will supply two things to the area: an easier means of east to west transport in a region where previously most routes had run north to south, and great reserve of food in the form of fish. Already a new industry has developed that can add greatly to indigenous staple diet of the population.

The prime object of the project was to assist industrialisation of the Federation by providing power. Many thousands of Africans had their first experience of industrial methods when they assisted with the construction of the great dam and power house at Kariba.

The 'Engineering' Appointments Section

PUBLIC APPOINTMENTS

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH and DEVELOPMENT DEPARTMENT
Research Laboratories, Leatherhead, Surrey

HEAT TRANSFER SECTION

CHEMICAL ENGINEERS, MECHANICAL ENGINEERS and PHYSICISTS are required with a sound knowledge of mass and heat-transfer. The work will consist of making a scientific analysis of the performance of large plants, with the object of improving efficiency and developing accurate design methods. There is ample scope for both fundamental and applied research and good experimental facilities are available.

Applicants should have an honours degree and, for the higher grades, considerable research experience in this field. Applications from newly qualified graduates will also be welcome.

Salaries according to duties and responsibilities, will be on scales within the range **£1,195-£1,775** p.a. or, up to **£1,300** p.a.

There are good opportunities for promotion to higher grades. Where necessary, consideration may be given for financial assistance towards house purchase.

Applications stating age, qualifications, experience, present position and salary, to the PERSONNEL OFFICER, 24/30 HOLBORN, LONDON, E.C.1, by 23rd May. Envelopes should be marked "Confidential Ref. ENG/163." C 10

KENT EDUCATION COMMITTEE
NORTH-WEST KENT COLLEGE
OF TECHNOLOGY

ASSISTANT (GRADE B) required in the MECHANICAL ENGINEERING DEPARTMENT to teach Workshop Technology in the City and Guilds Machine Shop Engineering and the National Certificate courses. Other subjects according to qualifications. Salary: £700 by £27 10s. to £1150.

Forms of application and further details obtainable from the PRINCIPAL AT THE COLLEGE, MISKIN ROAD, DARTFORD. C 14

UNIVERSITY OF DURHAM
KING'S COLLEGE
NEWCASTLE UPON TYNE
GEORGE ANGUS STUDENTSHIP

Applications are invited for the above-mentioned STUDENTSHIP, of the value of £400 per annum, with remission of composition fee, which is available annually for postgraduate research in the Departments of Chemistry, Physics or Mechanical Engineering, as a result of a gift from Messrs. George Angus & Co., Ltd., of Newcastle upon Tyne.

The Studentship is open to graduates of approved Universities, or candidates hoping to graduate in June, 1960. It is tenable for two years, but may be renewed for a third year in special circumstances.

Forms of application and further particulars may be obtained from the undersigned, to whom completed application forms should be returned as soon as possible.

G. R. HANSON,
Registrar of King's College. C 23

BRADFORD INSTITUTE
OF TECHNOLOGY

Applications are invited for the position of

PRINCIPAL LECTURER IN
MECHANICAL ENGINEERING

Candidates should be qualified to teach to final degree standard, preferably in Thermodynamics, and should have had adequate industrial experience.

The successful candidate will be expected to assist the Head of the Department with the administrative work of the Department and will be encouraged to develop industrial contacts.

Salary scale: £1750 to £1900 per annum.

Previous industrial and research experience, at a suitable level, will be taken into account in fixing the commencing salary.

Further particulars and forms of application may be obtained from the REGISTRAR, BRADFORD INSTITUTE OF TECHNOLOGY, BRADFORD 7.

HENRY PATTEN,
Clerk to the Governors. C 21

CITY OF BIRMINGHAM
PUBLIC WORKS DEPARTMENT
MECHANICAL AND PUBLIC
LIGHTING SECTION

Applications are invited for the post of PRINCIPAL ASSISTANT ENGINEER (MECHANICAL, HEATING and VENTILATION).

Salary in accordance with salary scales for senior officers: Grade "B", £1305-£1485 per annum.

Applicants must be Associate Members of the Institution of Mechanical, Electrical or Heating and Ventilating Engineers or hold the Higher National Certificate in Mechanical or Electrical Engineering (with five years experience).

The duties of the post include the design of mechanical and heating services and installations in civic buildings, municipal offices, multi-storey flats, car parking garages, fire and police stations, schools, baths, salvage destructor plants, pump stations, etc.

Candidates must have had experience in the design, specification and supervision of contracts associated with the above work and be experienced in the supervision and control of staff.

The appointment is permanent, superannuable and subject to a medical examination.

Applications endorsed "Principal Assistant Engineer," stating qualifications, age and experience, together with the names of two referees, should reach the undersigned not later than the 28th MAY, 1960.

Canvassing disqualifies.

HERBERT J. MANZONI,
City Engineer and Surveyor.

CIVIC CENTRE,
BIRMINGHAM, 1.
2nd May, 1960. C 17

THE POLYTECHNIC
309 REGENT STREET, LONDON, W.1
DEPARTMENT OF CIVIL AND
MECHANICAL ENGINEERING

Applications are invited for the following full-time posts:—

(1) LECTURER in Mechanical Engineering to teach a range of subjects to final Degree and Diploma students.
(2) GRADE B TEACHER for similar range of subjects.

The appointments will commence on 1st September, 1960. The salary scale for (1) is £1370 rising by annual increments of £35 to a maximum of £1550 per annum plus London allowance of £38 or £51, and for (2) the maximum of the scale for a graduate is £1240 per annum plus London allowance of £38 or £51 with additional allowances for good honours degree and training where applicable.

Further particulars and a form of application, which should be returned not later than 20th May, may be obtained by sending a stamped addressed foolscap envelope to the undersigned.

J. E. RICHARDSON,
Director of Education. C 28

ENGINEERING

TECHNICAL MANAGER

A Technical Manager is required to lead and direct the Design and Technical activities—both at Home and Overseas—on the existing and new projects of a world-renowned engineering company, whose Works and Head Office are located in the London area.

This is a new post, created by the Company's continued expansion, and carries a salary of £2,500-£3,000 a year.

The successful candidate will also act as the Company's representative in development co-ordination, and liaise at Director level with associated Companies in the furthering of a variety of projects; execute Design Studies and Surveys on competitive equipment, establishing policy on design trends and potential markets; represent the Company on such national bodies as required by current projects; and provide technical articles on the Company's products and activities for prestige and sales purposes.

The men we are looking for must have initiative and sound, balanced judgment, allied with considerable experience in light engineering design and preferably a knowledge of modern control engineering. He must also possess an Engineering degree or be a member of the appropriate professional institute, and be aged approximately 40 to 50.

Write, giving the fullest possible details of qualifications, experience, education and age, to:—

Mr. N. M. Pritchard, AUSTIN KNIGHT LIMITED
Incorporated Practitioners in Advertising,
212a, Shaftesbury Avenue, London, W.C.2.

All applications will be treated in the strictest confidence.

B 998

CIVIL ENGINEERING PLANT MANAGERS AND ENGINEERS

RICHARD COSTAIN LIMITED have vacancies for

PLANT MANAGERS responsible for the control and operation of civil engineering plant valued £½ million to £2 million on major overseas contracts.

PLANT DEVELOPMENT ENGINEERS to be appointed to the plant development department at Head Office. These Engineers will be concerned with the assessment of performance of newly developed plant, layout and design of contractors' plant installations, and advice to the operating contractors on the economic use and type of plant for specific applications.

Candidates for both categories of appointments aged 30-45 should possess A.M.I.Mech.E. or equivalent qualification and should have preferably not less than 5 years experience in connection with contractors' plant.

Applications should be addressed to:—

SENIOR PERSONNEL OFFICER
111, WESTMINSTER BRIDGE ROAD
LONDON, S.E.1

C 22

HER MAJESTY'S OVERSEAS CIVIL SERVICE
GOVERNMENT OF HONG KONG
MECHANICAL ENGINEERS
PUBLIC WORKS DEPARTMENT

To supervise workshops engaged in the repair of motor vehicles, refrigerators, electrical appliances, etc.

Pensionable appointment. Salary according to experience within the range £1500-£2865. Free passages. Rented quarters.

Candidates under 45 years of age must be A.M.I.Mech.E. with considerable experience in workshop practice and management and preferably with knowledge of electrical engineering.

Write DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving full names, age, qualifications and experience, quoting BCD112/51/024/D5. C 27

UNIVERSITY OF DURHAM
KING'S COLLEGE
NEWCASTLE UPON TYNE
RAMBUSH STUDENTSHIP

Applications are invited for the above-mentioned STUDENTSHIP, of the value of £350 per annum, with remission of composition fee, which is available for postgraduate research in the Departments of Chemical, Mechanical and Civil Engineering, as a result of a gift from Power-Gas Corporation, Ltd.

The Studentship is open to graduates of approved Universities, or holders of approved qualifications. It is tenable for two years, but may be renewed for a third year in special circumstances.

Forms of application and further particulars may be obtained from the undersigned, to whom completed application forms should be returned as soon as possible.

G. R. HANSON,
Registrar of King's College. C 24

LANCASHIRE EDUCATION COMMITTEE
WIDNES EXCEPTED DISTRICT
WIDNES COLLEGE OF FURTHER EDUCATION
ENGINEERING DEPARTMENT
SENIOR LECTURER
(ELECTRICAL ENGINEERING)

Required in September, or as soon after as possible: GRADUATE, good industrial experience in Heavy Electrical Engineering, teaching experience, to take charge, under Head of Department, of all instruction in Electrical Engineering, and to teach mostly at A1 and A2 level.

Excellent laboratories completed in 1955. Main phase of new college completed next year.

Salary: Senior Lecturer, £1550 by £50 to £1750.

Application forms, to be returned immediately, from BOROUGH EDUCATION OFFICER, EDUCATION OFFICE, LUGSDALE ROAD, WIDNES. C 20

LECTURESHIP IN ENGINEERING
UNIVERSITY COLLEGE OF SWANSEA

A vacancy exists for an ASSISTANT LECTURER or LECTURER in the Department of Engineering at Swansea. Applicants should preferably have interests in the general field of Strength of Materials, but those with interests in any branch of either Civil or Mechanical Engineering will be considered.

ASSISTANT LECTURER:

Applicants should hold a good Honours degree and have at least one year's industrial or post-graduate experience. Research work is strongly encouraged and the assistant may register for a Ph.D. degree.

LECTURER:

Applicants should hold a good Honours degree and have not less than three year's post-graduate research or industrial design experience. It is hoped to appoint a man who will be active in some field of research of his own choice, although if he so wishes, he may join an existing project.

A revision of salary scales is now under discussion. The present scales are:

Assistant Lecturer £700-£850 p.a.
Lecturer ... ... £900-£1650 p.a.

and the initial salary can be at any point within these ranges. F.S.S.U. benefits and family allowances.

Further particulars can be obtained from the REGISTRAR, UNIVERSITY COLLEGE, SINGLETON PARK, SWANSEA, with whom applications six copies) should be lodged before MAY 24, 1960.

B 989

ADMIRALTY
NAVY WORKS DEPARTMENT
ARCHITECTURAL AND CIVIL ENGINEERING ASSISTANTS

Vacancies exist in Navy Works Department Drawing Offices for Architectural and Civil Engineering Assistants as shown. Posts are non-pensionable. Opportunities for transfer to Established staff will occur.

ENGINEERING ASSISTANTS.

Vacancies exist at Pinner (Middlesex), Portsmouth, Devonport, Liverpool, Chatham, Rosyth, Greenock, Macrihanish and Glen Douglas, and occur at Establishments elsewhere in the United Kingdom from time to time.

Applicants must be competent Draughtsmen and experienced designers in one or more of the following types of civil engineering works:—Structural steelwork; reinforced concrete; dock and harbour works; airfield construction; oil fuel schemes; roads, rail services and water supplies. O.N.C. or equivalent qualification. For the posts at Macrihanish and Glen Douglas preference will be given to candidates with surveying and setting out experience.

ARCHITECTURAL ASSISTANTS.

Vacancies exist at Pinner (Middlesex), and Portsmouth. Applicants must be competent Draughtsmen and will be required for work with Professional Architects on the preparation of designs for a wide range of new works, including new housing designs and estate layouts; all forms of accommodation; specialised technical buildings and industrial buildings in H.M. Dockyards. Preference given to candidates studying for professional qualifications.

SALARY: (National Rate—subject to slight variation dependent on location): starting from £550 p.a. (at age 21) to £760 p.a. (28 and over): maximum of scale—£875 p.a. Opportunities occur for promotion to Leading grade—salary maximum £1025 p.a. National Rate.

Five-day week; Annual Leave 18 days rising to 22 after 10 years.

Consideration will be given to successful candidates being granted assistance to obtain professional or technical qualifications.

Candidates, who must be British subjects, are invited to apply, in writing, (giving details of experience) to DIRECTOR GENERAL, NAVY WORKS, ADMIRALTY, CHAMBERLAIN WAY, PINNER, MIDDLESEX.

Interview will be arranged locally. B 915

TEMP EXPERIMENTAL OFFICER

MINISTRY OF POWER, H.Q., LONDON, require TEMP. EXPERIMENTAL OFFICER, preferably under 31. Duties:—abstracting scientific articles; preparation of surveys of current literature, briefs and memoranda on fuel and power subjects. Min. Quals. H.N.C. or Inter.B.Sc. or equiv. Some knowledge of terms used in fields of fuel and power, ability to translate French and German essential; knowledge of Russian an advantage. Salary: £1005-£1233 (men), £985-£1203 (women). Five-day week. Prospects of Establishment.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A.196/OA. B 968

LANCHESTER COLLEGE OF TECHNOLOGY
COVENTRY

Principal: A. J. RICHMOND, B.Sc.(Eng.)(Lond.), Ph.D., M.I.Mech.E.

Applications are invited for following posts, duties to commence 1st September, 1960:—

One SENIOR LECTURER in AIRCRAFT STRUCTURES.
Two SENIOR LECTURERS IN ELECTRONICS.
One LECTURER in PRODUCTION ENGINEERING.
One ASSISTANT LECTURER, GRADE B, IN PRODUCTION ENGINEERING.

Salaries: Senior Lecturers (men), £1550 by £50 to £1750 p.a. Lecturers (men), £1370 by £55 (4) and £40 (1) to £1550 p.a.

In certain circumstances candidates for above grades may be paid a commencing salary above the minimum of the respective scales.

Assistant Lecturer, Grade B (men) £700 to £1150 plus additions at minimum and maximum for training and graduate equivalent which may amount to £285 p.a. Commencing salary depends on age and experience.

Women receive slightly less at present but equal pay will apply from April, 1961.

Applicants should be well qualified academically and professionally and have had appropriate industrial or research experience. Previous teaching experience not essential. Excellent opportunities for research and professional work in new College buildings provided with modern facilities and equipment.

Further particulars and application forms (stamped addressed foolscap envelope) from REGISTRAR, LANCHESTER COLLEGE OF TECHNOLOGY, Temporary address: BUTTS, COVENTRY, to whom completed forms should be returned by 16th MAY, 1960.

W. L. CHINN,
Director of Education. C 4

BRADFORD INSTITUTE OF TECHNOLOGY

Applications are invited for the posts of

SENIOR LECTURER IN MECHANICAL ENGINEERING
LECTURER IN MECHANICAL ENGINEERING

Candidates should be well qualified and industrial and research experience would be a recommendation. The successful candidates will be required to teach one or more subjects to honours degree standard. They will be encouraged to undertake research and adequate facilities will be available.

Salary scales: Senior Lecturer, £1550-£1750 per annum. Lecturer, £1370-£1550 per annum.

Previous industrial and research experience at a suitable level may be taken into account in fixing the commencing salary.

Further particulars and forms of application may be obtained from the REGISTRAR, BRADFORD INSTITUTE OF TECHNOLOGY, BRADFORD 7.

H. PATTEN,
Clerk to the Governors. C 19

RESEARCH FELLOWSHIPS

RESEARCH FELLOWSHIPS (3 years) in GOVERNMENT SCIENTIFIC ESTABLISHMENTS. Value £1150-£1400 p.a. (Senior) and £800-£1100 p.a. (Junior). A very wide range of topics, especially in the PHYSICAL SCIENCES; also several vacancies in various branches of BIOLOGY. Qualifications: normally first or second class honours degree; evidence of high standard of ability in research; and at least 2 years' post-graduate research experience (3 years for Senior Fellowships). No age limits. F.S.S.U.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting **S 5060/60.** C 2

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

Applications are invited for SENIOR LECTURERS and LECTURERS in the Department of Mechanical Engineering.

Applicants should have had industrial or research experience and, preferably, should possess a university degree. Encouragement will be given to undertake research and consulting work.

Salary scales: Senior Lecturer, £1550 by £50 to £1750; Lecturer, £1370 by £35 to £1550. The commencing salaries will be determined by previous experience and qualifications. The posts are pensionable.

Application forms and further information may be obtained from the ACADEMIC REGISTRAR. (In reply quote 8/D.) C 43

STAFFORDSHIRE COUNTY COUNCIL
EDUCATION COMMITTEE
CANNOCK CHASE MINING AND TECHNICAL COLLEGE

Principal: C. D. GRAHAM, B.Sc.(Eng.)(Hons.), M.I.Mech.E., A.F.R.Ae.S.

Applications are invited from suitably qualified persons for the following teaching posts which have arisen through the growth of the College and promotion of existing staff.

ENGINEERING DEPARTMENT

One SENIOR LECTURER to teach Mathematics to Advanced classes and to advise on the teaching of Mathematics throughout the College. Ability to offer Electrical and/or Physics would be advantageous. Applicants should have a good degree and previous teaching experience.

Two ASSISTANTS GRADE "A" to teach one or more of the following subjects: Engineering Science and Engineering Drawing to National Certificate students and Science, Calculations, and Drawing to Craft students. Industrial and previous teaching experience are desirable.

MINING DEPARTMENT

One GRADE "B" ASSISTANT to teach Mining Technology, Mining Science, and Geology to National Certificate students. A degree and teaching experience are desirable.

Salaries in accordance with the Burnham (Technical) Scale, i.e.:—

Senior Lecturer: £1550 by £50 to £1750.
Grade "B" Assistants: £700 by £27 10s. to £1150.
Grade "A" Assistants (men): £520 by £27 10s. to £1000.

Forms of Application, returnable by 25th May, 1960, together with further particulars relating to the appointments may be obtained from the DIRECTOR OF EDUCATION (STAFFING DEPARTMENT), COUNTY EDUCATION OFFICE, STAFFORD, on receipt of a stamped addressed foolscap envelope. Candidates should state for which post forms are required. C 42

RHODESIA RAILWAYS
VACANCIES FOR CIVIL ENGINEERS

Vacancies exist on the Permanent Staff for CIVIL ENGINEERS for service in the Chief Engineer's Department of the Rhodesia Railways. Normally applicants under 30 years of age will be given preference.

Applicants under 25 years of age should possess a degree in Civil Engineering.

Applicants over 25 years of age should possess a degree in Civil Engineering and be prepared to sit Part III of the examination for Corporate Membership of the Institution of Civil Engineers within a reasonable period, or should be Corporate Members of the Institution.

Applications will also be considered from men who have passed Parts I and II of the Institution examinations, for appointment to the grade of Technical Assistants until such time as they become Corporate Members and are, therefore, eligible for transfer to the Professional Grade.

The salary scale for Assistant Engineers is £1000 to £1800 per annum, plus a Cost-of-Living Allowance at present calculated on 12 per cent of the basic salary, subject to a maximum of £13 15s. 0d. per month. The commencing salary will depend upon previous experience of the applicant. The annual increments in the above scale are as follows:—

£1000 by £100 to £1200
£1200 by £50 to £1500
£1500 by £100 to £1800

Further advancement to the grade of District Engineer on the salary scale of £2000 by £100 to £2300 per annum is possible as and when vacancies occur. Promotion to these posts is by selection.

Membership of the Contributory Pension Fund and Medical Fund is obligatory and the usual Railway privileges in respect of travelling concessions, leave, etc., will apply.

Income Tax in the Federation is not unreasonable and, at the present time, a married man with one child, earning £1100 per annum would not be liable.

Housing is provided at a moderate rental for married Engineers; the rental payable is £7 10s. 0d. per month for Officers in receipt of a salary under £1700 per annum, and £10 per month for Officers in receipt of higher salaries.

Full particulars with regard to age, training, qualifications and experience should be submitted, together with copies of recent testimonials, to:—

THE LONDON AGENT,
RHODESIA RAILWAYS,
241, SALISBURY HOUSE,
LONDON WALL, LONDON, E.C.2

from whom full details regarding conditions of service may be obtained. C 46

KINGSTON UPON HULL
EDUCATION COMMITTEE
COLLEGE OF TECHNOLOGY

Principal: EMLYN JONES, M.Sc., F.R.I.C.

Applications are invited for the following posts:—

(*a*) LECTURER in ELECTRICAL ENGINEERING to teach to degree and Higher National Certificate standard. Candidates should be honours graduates with experience of heavy current and control systems.

Salary: Burnham Technical Scale: £1370 by £35 to £1510 by £40 to £1550.

(*b*) ASSISTANT (GRADE B) for ELECTRICAL ENGINEERING, to teach electrical telecommunications and allied subjects to Ordinary National Certificate and Technicians' Certificate standards.

Salary: Burnham Technical Scale, £700 by £27 10s. to £1112 10s. by £37 10s. to £1150, with additions for training and graduate qualifications and increments for suitable teaching and industrial experience.

Further particulars and application forms, to be returned as soon as possible, may be obtained from the CHIEF EDUCATION OFFICER, GUILDHALL, KINGSTON UPON HULL. C 53

BIRMINGHAM REGIONAL HOSPITAL BOARD

The Board require Engineers in the following grades:—

(*a*) PRINCIPAL ASSISTANT ENGINEER
£1665 to £2035 per annum.
(*b*) GENERAL GRADE ENGINEER
£910 to £1600 per annum.
(*c*) ENGINEERING ASSISTANT
£600 to £1070 per annum.
(*d*) ENGINEERING DRAUGHTSMAN
£550 to £1250 per annum.

Interesting and responsible work in Regional Engineer's Department on design and installation of mechanical and electrical services for new hospitals and alterations to existing. Previous hospital experience desirable but not essential. Corporate membership of Chartered Engineering Institution essential for Principal Assistant grade.

Applications, giving three referees, to SECRETARY, 10 AUGUSTUS ROAD, EDGBASTON, BIRMINGHAM 15, by 3rd JUNE, 1960, from whom further details can be obtained. C 60

SIEMENS
have a vacancy for an

ELECTRICAL ENGINEER
FOR GERMAN-ENGLISH TRANSLATIONS

Applications are invited from British-trained engineers with a good general education and sound technical training, preferably also with practical experience in the application of electric equipment. Good working knowledge of German is essential. The ability to write clearly and concisely will be expected of candidates.

A five-day week is worked, with generous holidays. Favourable housing conditions for permanent staff.

Apply, stating age, education, qualifications, experience and salary required, to:—

SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT

Personalabteilung, Erlangen, Werner-von-Siemens-Straße 50, Germany. C 12

NUCLEAR POWER STATION

COMMISSIONING ENGINEER

A company engaged in the design, construction and commissioning of nuclear power stations has a vacancy for a SHIFT COMMISSIONING ENGINEER in its COMMISSIONING DEPARTMENT. The successful candidate, who will be trained in the operation of nuclear power stations, must have some experience as a shift Charge Engineer in a conventional power station. He should either be an Associate Member of a major professional Institution or hold qualifications leading to Associate Membership.

Applications should be addressed to BOX EG, C 35, Offices of ENGINEERING, and give details of age, qualifications, experience and current salary.

EDWARDS HIGH VACUUM LIMITED
MANOR ROYAL · CRAWLEY · SUSSEX

A molecule has great freedom of movement when in vacuum

WE OFFER SCIENTISTS AND ENGINEERS GREATER FREEDOM OF ACTIVITY IN VACUUM

The increased demand for our wide variety of products means that we have had again to increase our production and research activities.

We would be interested to hear from suitable qualified personnel to fill the following posts:—

SENIOR PRODUCTION ENGINEERS	METHODS STUDY ENGINEERS
ELECTRICAL ENGINEERS	MECHANICAL ENGINEERS
CHEMICAL ENGINEERS	PHYSICISTS
BUYERS	SENIOR AND JUNIOR DRAUGHTSMEN
INSPECTORS	PLANNING ENGINEERS

Commencing salaries will be in accordance with age and experience. Pensions and Bonus Schemes are operated. Housing may be available. Please write, giving full details of experience and qualifications to the PERSONNEL MANAGER.

C 56

SENIOR SALES ENGINEER

Machine Tools

Important British Agency in India require SENIOR ENGINEER for their Sales and Agency Division.

Applicant, preferably below 45 years of age, should have knowledge of the steel industry, be familiar with all types of machine tools, have sales experience, and ability to conduct correspondence.

Salary up to £2500 per annum for suitable candidate, plus flat, car, and entertainment and travelling expenses, etc. Initial engagement for three years with passages paid for self and family.

Applications will be treated in the strictest confidence.

For interview in London send fullest details of education, qualifications and experience, to:—

BOX No. 3382, c/o CHARLES BARKER & SONS LIMITED
GATEWAY HOUSE
LONDON, E.C.4 C 25

SENIOR ENGINEER

Required by internationally known manufacturers of laboratory apparatus and chemical plant in glass. Duties will include the supervision of a toolroom developing and fabricating plant and equipment for this highly specialised industry. The position offers unusual scope and opportunities in a progressive field. Applicants should have at least H.N.C. in mechanical engineering, excellent general light engineering background, preferably in machine tool manufacture and mechanical instruments. Upper age limit 45. Contributory pension scheme, free life assurance scheme. Please apply in writing with details, including age and salary required, to the:—

Works Director,
QUICKFIT & QUARTZ LTD.
Heart of STONE, STAFFORDSHIRE. C 54

UNIVERSITY OF CANTERBURY
CHRISTCHURCH, NEW ZEALAND
LECTURERS IN CIVIL ENGINEERING

Applications are invited for positions of LECTURER in the DEPARTMENT OF CIVIL ENGINEERING. Applicants should have a degree in Civil Engineering of a recognised University, teaching experience at a University, or have held a responsible position in a branch of Civil Engineering.

The salary attached to the positions will be at the rate of £1250 per annum, rising by annual increments of £75 to £1700 per annum. Commencing salary will be in accordance with qualifications and experience.

Approved fares to Christchurch will be allowed for the appointee, his wife and children, together with actual removal expenses within certain limits.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 GORDON SQUARE, LONDON, W.C.1.

Applications close, in New Zealand and London, on 30th June, 1960. C 5

UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
LECTURER IN INDUSTRIAL ENGINEERING

Applications are invited for the above post.

Candidates should have a good Honours Degree, some professional and preferably also research experience in industrial engineering subjects, such as work study, plant layout, production and inventory control and application of operational research techniques. The successful applicant will be required to assist in teaching at undergraduate and post-graduate levels and in research. Salary in range £1050 by £50 to £1400 (efficiency bar) by £75 to £1850 per annum, plus £60 per annum London Allowance. Starting point dependent upon qualifications and experience. F.S.S.U. benefits and Family Allowances.—Applications should be sent to the HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT, IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON, S.W.7. C 51

CIVIL ENGINEERS FOR DEPARTMENT OF MAIN ROADS NEW SOUTH WALES AUSTRALIA

Applications are invited from GRADUATES (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

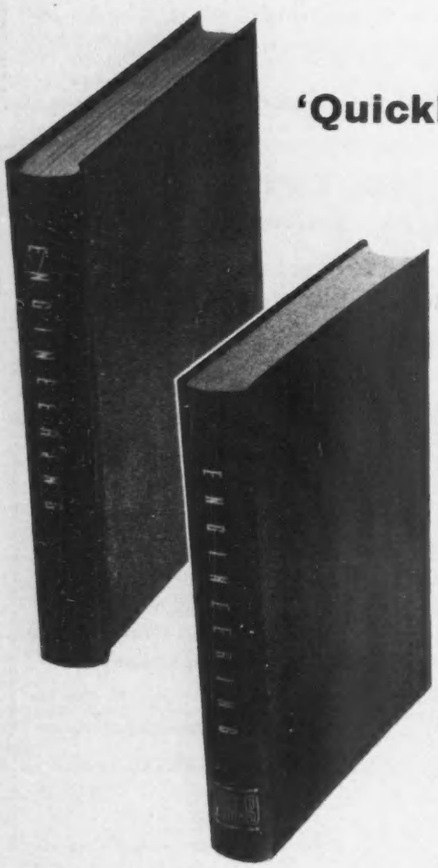
Applications should be made on forms obtainable from the AGENT GENERAL FOR NEW SOUTH WALES, 56 STRAND, LONDON, W.C.2. C 61

BUCKINGHAMSHIRE EDUCATION COMMITTEE
AYLESBURY SECONDARY TECHNICAL SCHOOL

Headmaster: R. B. EATON

Required from 1st September, 1960, qualified ASSISTANT MASTER for METALWORK, ENGINEERING WORKSHOP PRACTICE and TECHNOLOGY, together with ENGINEERING DRAWING. This is a developing mixed secondary technical school for which new buildings are being planned. Previous teaching experience is essential.

Forms of application may be obtained by forwarding a stamped addressed envelope to the HEADMASTER AT WALTON ROAD, AYLESBURY, to whom they should be returned as soon as possible. C 55



'Quickbinde' and Permanent-Binding Cases

The "Quickbinde" and permanent-binding cases are designed to reflect the contemporary character of the front cover and editorial pages of "Engineering".

Extreme left: the improved "Quickbinde", finished in dark green with washable covers. Lettering blocked in silver. Takes one volume of "Engineering" editorial pages or six issues complete with advertisements. Pages secured by three spring clips. Price 18s. 6d. post paid. Pair of levers (for first binder only) 9d. extra.

Left: the permanent-binding case for a volume of editorial pages. Finished dark green in washable durable material; lettering, volume number and months, and year blocked in silver. Prices: one case 17s. 6d. post paid; supplying one case and binding your pages 52s. 6d. post paid. When ordering, please specify volume number and dates.

Orders and remittances to "Engineering" 36 Bedford St. Strand, London, W.C.2. (Telephone: TEMple Bar 3663)

ENGINEERING

UNIVERSITY OF AUCKLAND
NEW ZEALAND
SCHOOL OF ENGINEERING

Applications are invited for the following appointments:—

SENIOR LECTURESHIP IN CIVIL ENGINEERING. Candidates should be University graduates in Civil Engineering. A higher degree and/or professional experience would be an advantage. The person appointed will be attached initially to the Hydraulic Engineering section of the Department of Civil Engineering and the duties will include instruction in Water Supply and Sewage Disposal in which particular fields previous professional or academic experience would be an advantage.

SENIOR LECTURESHIP IN ELECTRICAL ENGINEERING. Candidates should be University graduates in Electrical Engineering; a higher degree would be an advantage. Previous lecturing experience is not essential.

SENIOR LECTURESHIP IN MECHANICAL ENGINEERING. Candidates should be University graduates in Mechanical Engineering. A higher degree would be an advantage. Previous lecturing experience is not necessary, especially if the candidate has had suitable professional experience in industry.

The salary scale for a Senior Lecturer is £1750 per annum rising to £2000 per annum by three annual increments, the first two of £100 and the third of £50. Commencing salary within this scale will be determined according to qualifications and experience. An allowance is made towards travel and removal expenses.

Further particulars and information as to the method of application should be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 GORDON SQUARE, LONDON, W.C.1.

Applications close, in New Zealand and London, on 30th JUNE, 1960. C 52

APPOINTMENTS OPEN

CHIEF ENGINEER—IRELAND

Large Commercial Undertaking in Dublin requires an experienced MECHANICAL ENGINEER. Applicant with Oil Industry as a background would be preferred. Age 30-45. The Company has good possibilities for development. Initiative and ability to work independently and supervise Department are essential. Salary according to qualifications. Pension Scheme. Car Allowance.—Reply in confidence to BOX C 18, Offices of ENGINEERING.

YOUNG CHEMIST OR
CHEMICAL ENGINEER

O. W. ROSKILL, INDUSTRIAL CONSULTANTS, 14 GREAT COLLEGE STREET, S.W.1, have an opening for a young chemist or chemical engineer, preferably with public school and university education for training in technical market research and other consulting work. An unusual combination of scientific outlook and ability to draft well is required, together with wide rather than highly specialised interest in technological matters. C 13

PORT OF MANCHESTER
ELECTRICAL ASSISTANT

THE MANCHESTER SHIP CANAL COMPANY have a vacancy for an ELECTRICAL ASSISTANT in the MECHANICAL ENGINEER'S DEPARTMENT.

Applications for the position are invited from candidates, who should be not more than 40 years of age, with either a university degree or corporate membership of the Institution of Electrical Engineers and with experience in the design, layout and maintenance of electrical equipment appertaining to dock and railway undertakings. The successful candidate will be required to pass a medical examination and to become a member of the Company's contributory superannuation scheme.

Applications, containing full particulars of age, education, qualifications, experience and salary envisaged, should be addressed to the MECHANICAL ENGINEER, MANCHESTER SHIP CANAL COMPANY, SHIP CANAL HOUSE, KING STREET, MANCHESTER 2, not later than 4th JUNE. Envelopes should be marked "E.A. PERSONAL." C 31

ELECTRICAL DRAUGHTSMAN

Westminster area. Professional firm dealing with large scale industrial installations, design processes and mechanical handling. On the electrical side general draughting ability and H.N.C. educational standard.—Please indicate age, education and experience to BOX C 29, Offices of ENGINEERING.

REPRESENTATIVES

REPRESENTATIVES wanted for correspondence abroad, high earnings, written instructions. Write: FORTUNA PUBLISHING CO., VIENNA 1/8, POSTFACH 40, AUSTRIA. G 824

SENIOR DRAUGHTSMAN

MAY & BAKER, LTD., DAGENHAM, ESSEX, require a SENIOR DRAUGHTSMAN with experience in the design and layout of chemical or similar plant installations. Applicants should have technical qualifications to Ordinary National Certificate level or higher. Salaries are reviewed annually. There is a Pension Fund and Life Assurance Scheme in operation. Excellent canteen and sports facilities. —Apply initially in writing to the PERSONNEL OFFICER, quoting Reference No. 19/60. C 16

ASSISTANT ENGINEER

ASSISTANT ENGINEER—in East Africa for English Public Company. Age 27-34, full apprenticeship in general engineering, qualifications to at least H.N.C., and sound practical experience of civil, mechanical and electrical engineering. Remuneration dependent on age and qualifications but not less than £1000 p.a. plus free accommodation, paid home leave and passages, free medical, contributory Provident Fund, etc.—Write fullest particulars and copy references to BOX A.E.D.965, c/o STREET'S, 110 OLD BROAD STREET, E.C.2. C 9

CIVIL ENGINEERS

Merz and McLellan require Senior and Junior Civil Engineers for design work at Newcastle-upon-Tyne. The appointments are permanent pensionable positions and are concerned with a variety of very heavy Civil Engineering construction works. Applications by letter in the first instance bearing reference SAR should be sent to MERZ & McLELLAN, CARLIOL HOUSE, NEWCASTLE-UPON-TYNE, 1 B 953

MECHANICAL ENGINEER

A vacancy exists for a MECHANICAL ENGINEER to design and erect experimental test rigs for use at low temperatures. The successful applicant will need to collaborate with scientists using the equipment in research and development projects. The research establishment is located on the Surrey/London border.

Graduates or engineers with equivalent qualifications are invited to write to BOX C 26, Offices of ENGINEERING.

SITE ENGINEER

SITE ENGINEER required by well known firm manufacturing a wide range of Mining, Roadmaking and Quarry Plant. Must be capable of directing all aspects of plant erection and controlling labour.—Full details of experience, age, salary required and when available, to BOX B 954, Offices of ENGINEERING.

REPRESENTATIVE

REPRESENTATIVE wanted by BARLOW & CHIDLAW, LTD., MANCHESTER 6, to take over their Midland area, in which they are well represented, on a commission basis. A good knowledge of gearing would be required. The vacancy caused by sudden death.—Replies giving full details of past experience will be treated in confidence. C 32

DESIGNER DRAUGHTSMEN

DESIGNER/DRAUGHTSMEN required for hydraulic and pneumatic valves. H.N.C. standard. Isleworth area. Applications with full details and salary required.—BOX B 945, Offices of ENGINEERING

DRAUGHTSMAN—MECHANICAL

Interested in wide variety of industrial plants and design process services required by Westminster consultants who are extending staff. Age, say 25-35 and salary would be considered in relation to education and experience.—Details of these please to BOX C 6, Offices of ENGINEERING.

ENGINEER

required to join the Engineering Section of the United Kingdom Atomic Energy Authority Health and Safety Branch to specialise in reactor containment technology with emphasis on the integrity of nuclear reactor pressure and steel containment vessels.

Applicants should have served a recognised engineering apprenticeship and be corporate members of a senior engineering institution or have an honours degree, or equivalent qualification, and several years' industrial or research experience. Practical experience in fabrication and material testing techniques involved in heavy engineering and a sound knowledge of solid mechanics and the metallurgy of steel is required. Detailed experience of the manufacture of large pressure vessels would be an advantage.

Starting salary will be assessed on the scale £1880-£2180 according to qualifications and experience.

Contributory superannuation. Staff housing scheme.

Send postcard for application form, quoting reference H.3/J.2, to ADMINISTRATION MANAGER, AUTHORITY HEALTH AND SAFETY BRANCH, RISLEY, WARRINGTON, LANCS.

Closing date: 23rd MAY, 1960. C 1

CHIEF ENGINEER

A progressive family business, which makes footwear at three factories in Midland towns, intends to appoint an Engineer to supervise all the group's engineering services. A first duty will be to devise and institute a preventive maintenance system and to secure the best productive efficiency from all machinery and plant.

Candidates should preferably be in the age group 27/33 or near it; have a good University Degree in Engineering coupled with a Graduate Apprenticeship and with some years experience in a responsible position as an Engineer in design or production. Essential qualities are a good mastery of fundamental engineering science and an ability to tackle diverse problems in an enterprising way because it is expected that problems of automation will soon have to be tackled so that a future of interesting and constructive work in a basic industry is assured for a versatile engineer.

An initial salary of around £1500 per annum is envisaged and problems of removal, superannuation, etc., will be treated sympathetically.

Applications in confidence to URWICK, ORR & PARTNERS, LTD., who have been asked to advise on this appointment should be sent to Urwick House, 14, Hobart Place, London, S.W.1, quoting reference CONTROL ENGINEERING, 1402 on the envelope. C 39

WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD.

Applications are invited for vacancies in London Office for the following posts:—

ASSISTANT CIVIL ENGINEER

Age approximately 28 to 35 years with a minimum of five years field experience on general civil engineering works. University Graduate or Corporate Member of Institution of Civil Engineers preferred.

ESTIMATOR

Age approximately 30 to 40 years with several years experience of civil engineering and building estimating, experience in sewerage and sewage disposal an advantage.

QUANTITY SURVEYOR

Age 30 to 35 years, experienced in preparation of monthly certificates and variations for final accounts.

Appointments based on London, but would involve visits to sites.

Salaries for the above posts will be in accordance with qualifications and experience.

Five-day week; Staff Canteen; Pension and Insurance Schemes; Staff Bonus

Write giving full particulars of qualifications and experience to:—

THE PERSONNEL OFFICER
WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD.
63/77 BROMPTON ROAD
LONDON, S.W.3 C 59

Another Opportunity in Iron and Steel

BISRA
YOUNG
RESEARCH ASSISTANTS

are required for Mechanical Engineering work of a varied and interesting nature, at the Association's Engineering Laboratories in London (Battersea). Short visits to Iron and Steel Works may be expected in the course of the work. An ordinary National Certificate, or better, in Mechanical Engineering is essential. Some workshop experience would be an advantage. Time off for study for further qualifications will be allowed.

Starting salary up to £825 per annum according to age, qualifications and experience. Five-day week. Canteen. Staff pension scheme.

Written applications only, quoting M.E.15, to the PERSONNEL OFFICER, THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION, 11, PARK LANE, LONDON, W.1, C 57

Design and Development Engineer

required by manufacturers of small gas turbines: the successful applicant must be able to take complete charge of projects. This is a permanent, pensionable position with excellent prospects for a really first class man.

Please write, stating experience, qualifications and age to:—

David Budworth Ltd,
Harwich, Essex
C 36

LAING

The following vacancies exist in the Research and Development Centre at Boreham Wood. The work is of an interesting nature and concerned with the development of new machines and processes connected with the Building and Civil Engineering Industries.

MECHANICAL ENGINEERS and GRADUATES

or Engineers with H.N.C. or equivalent are required for work involving the study, performance and development of the Mechanisation techniques applied within the Contracting Industry. Site experience in the operation of Contractors' Plant an advantage.

DRAUGHTSMEN

Senior and Junior Draughtsmen are required for work on the development of new and improved types of Contractors' Plant.

All these posts are permanent and progressive. Pension Scheme.

Applicants should write in the first instance to:

Personnel Manager,
(M.D.E.S)
John Laing & Son Limited
London, N.W.7
C 15

SENIOR DESIGNER

required by DRYSDALE & CO., LTD., YOKER, GLASGOW, W.4. An excellent opportunity is open to a suitable man over 25 years of age. Applicant should preferably have experience in the design and installation of Centrifugal Pumps and their associated machinery. Life Assurance and Pension Scheme in operation. Five-day week.—Apply to the SECRETARY, giving full details of qualifications and salary required. C 58

RESIDENT SITE SUPERVISORS

J. DOUGLASS MATHEWS & PARTNERS, Chartered Architects, require experienced resident site supervisors on a permanent staff basis. Applicants must be prepared to go anywhere in the United Kingdom for resident appointment of one, two or three years. Salary £1250-£1750, according to job, experience and qualifications. Applicants to give names of at least three architect or engineer references.—Reply to 3, EBURY STREET, LONDON, S.W.1. C 47

MECHANICAL ENGINEER

BRITISH OXYGEN RESEARCH & DEVELOPMENT LTD. have a vacancy for a MECHANICAL ENGINEER to undertake development work on pumps for fluids at low temperatures. Applicants should have a degree in mechanical engineering or equivalent qualifications and preferably some experience of pump design.—Please write to the SECRETARY, BRITISH OXYGEN RESEARCH & DEVELOPMENT LTD., DEER PARK ROAD, LONDON, S.W.19. C 37

THE GLACIER METAL COMPANY

Invites applications for the post of

SENIOR APPLICATIONS ENGINEER

The Company has recently established within its Research and Development Organisation a new department whose function is to use the latest research knowledge in advising customers on all aspects of bearing design.

An appointment has now to be made in which the Engineer will be responsible to the Manager of the new department and will have initially one assistant. The work entails a wide and interesting range of contacts in the engineering industry.

As Technology advances new mechanical designs raise new bearing problems and new bearing designs make possible innovations in the design of machinery. A senior Applications Engineer is responsible both for devising solutions to bearing problems raised with the Company by its customers and for searching out areas where such innovations are practical.

Applicants should have a good Honours Degree in Engineering, Physics or Mathematics, together with a completed apprenticeship. Experience in Research, Design or Development work would be useful.

Salary Range: £1350 to £1830 per annum.

Applications should be sent to PERSONNEL DIVISIONAL MANAGER (REF. SAE), THE GLACIER METAL COMPANY EALING ROAD, ALPERTON, WEMBLEY, MIDDX. C 50

DESIGN DRAUGHTSMAN

A vacancy exists for a top-class man to carry out prototype and production design of precision instruments. Applicants must have at least H.N.C. and five years' design experience in this field, backed by a sound workshop training. Maximum age 35 years. We expect the successful applicant to put an exceptional effort into his work, but the problems involved are interesting and cover a wide field. Prospects are good, and an attractive salary will be offered to the right man.

Write, in confidence, to MANAGING DIRECTOR/TMIO, L. OERTLING LTD., CRAY VALLEY WORKS, ST. MARY CRAY, ORPINGTON, KENT. C 41

PERFORMANCE ENGINEERS

DOWTY NUCLEONICS LIMITED require ENGINEERS for theoretical design work on a variety of new projects (not nuclear). The preferred age range is 20 to 30, and applicants should have a degree or equivalent qualifications. Interest and experience in heat transfer or fluid dynamics would be an advantage. Working conditions and facilities are good.

Write in confidence to:— THE CHIEF ENGINEER DOWTY NUCLEONICS LTD. BROCKHAMPTON PARK ANDOVERSFORD, GLOS. C 45

THE DISTILLERS COMPANY LIMITED

PROJECT ENGINEER

The Company invites applications for an appointment as Project Engineer in the Chemical Division; attractive opportunities for further progress within the Division and the Company are attached to this post.

A Project Engineer is concerned with the design, installation and maintenance of carbon dioxide equipment supplied to customers, and with giving customer service on technical problems; he supervises the work of at least five Field Service Engineers.

This Vacancy arises in the London headquarters of the Division. Candidates, aged between 25 and 35, should hold a degree or equivalent professional qualification in mechanical engineering and should have practical engineering experience. Knowledge of pressure vessels for chemical plant is an essential qualification, and some experience of electrical installations would be an advantage.

Write:— STAFF MANAGER THE DISTILLERS COMPANY LIMITED 21-22 BOLTON STREET LONDON, W.1.

Quote Ref. 44/60E. C 44

THE HARLAND ENGINEERING COMPANY LIMITED · ALLOA

require several

SENIOR DRAUGHTSMEN

in connection with an expanding development programme in the field of centrifugal pumps, hydraulic turbines and medium/large electrical rotating machinery.

Experience in these products whilst advantageous is less important than thorough knowledge of modern mechanical engineering, stress analysis, materials selection and application, and up to date draughting methods.

The Company offers good salaries and working conditions with contributory pension scheme, extended holidays after twelve months and assistance with house acquisition or purchase.

Replies, giving full particulars of age, qualifications and experience, will be treated in strict confidence and should be sent marked "PERSONAL" to— CHIEF DRAUGHTSMAN, B.E.P. WORKS, ALLOA, SCOTLAND. G 882

COLLEGE OF ADVANCED TECHNOLOGY, BIRMINGHAM

Applications are invited for the post of

READER in MECHANICAL ENGINEERING

Previous experience in research is essential and the successful candidate will be required to initiate research in his particular subject and undertake a limited amount of lecturing on advanced topics.

Salary Scale: (Men) £1,800—£2,100

Further particulars and forms of application from

The Bursar, College of Advanced Technology, Gosta Green, Birmingham, 4.

Applications to be received within 14 days of this advertisement. Please quote "K."

K. R. PILLING, Clerk to the Governors B 999

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates: per page (12 in. by 9 in.) £100
half page £54
quarter page £29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates: per page (12 in. by 9 in.) £100
per half page £54
quarter page £29
per single column inch .. .. £2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent. on 52.

BOX NUMBER: 2s.

Company Meetings

Quarter page, £29; half page, £54; full page, £100.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2.

(Telephone TEMple Bar 3663).

THE HOFFMANN MANUFACTURING COMPANY

Record Turnover Achieved

The annual general meeting of The Hoffmann Manufacturing Company Limited was held on May 4 in London, Mr. J. W. Garton, J.P. (Chairman and Managing Director), presiding.

The following is an extract from the statement by the chairman which had been circulated with the report and accounts for the year ended December 31, 1959:—

In the year 1959 which is now under review we achieved a record turnover consequent upon a marked improvement in the order position from the middle of the year onwards.

The order book at this time is in a very healthy state. but I would personally wish to see increased investment in capital equipment, and whilst there is some indication of this trend the emphasis would still appear to be mainly on consumer goods.

The profit of the Hoffmann Group for 1959, before taxation, but after all other charges, including Debenture interest, amounts to £1,704,511 and compares with £1,206,476 for the previous year. Income Tax and Profits Tax absorb £717,340 against £581,474 in 1958. The net profit of the Group for the year 1959, after taxation is, therefore, £987,171 and compares with £625,002 for 1958.

The Directors recommend a Final Dividend of 29½ per cent. less tax, which with the Interim Dividend already paid of 6½ per cent., less tax, makes a total dividend of 36 per cent., less tax, for the year.

The Group Capital Commitment for plant and machinery at the 31st December, 1959, amounted to £1,189,683, and the major part of this new equipment will be installed by the middle of the current year. This substantial expenditure has been made necessary by the increasing demand for our products,

This capital programme will be financed from the internal resources of the Group.

The Directors give continuous attention to the repairing and maintenance of the buildings, plant and machinery.

The excess of Current Assets over Current Liabilities at the close of 1959 amounted to £4,814,473 compared with £4,192,972 at the close of 1958.

Subsidiary and Associated Companies

Hoffmann Gloucester Limited has again had a very good year and continues to play an important part in the Group's activities, with its combination of special bearings and standard group products.

Hoffmann Tweedales Limited again experienced unsatisfactory trading conditions due to the reduced demand for its products by the textile machinery trade but the position may improve later this year as a result of marketing new products which have been recently developed and which are now undergoing tests.

Capital Reorganisation

At the 31st December, 1959, the Parent Company's Fixed Assets Replacement Reserve stood at £2,000,000 and the Directors consider that in view of the considerable amount already spent on capital equipment, it would now be prudent to capitalise part of this Reserve, the balance remaining on the Reserve Account being ample cover for that part of the outstanding capital expenditure commitment of the Parent Company at the 31st December, 1959, of £718,751, which relates to increased cost of replacement.

The Directors still feel that the issued share capital does not adequately reflect the capital actually employed in the Company's business and they therefore propose that the sum of £1,000,000 part of the amount standing to the credit of the Parent Company's Fixed Assets Replacement Reserve, be capitalised and distributed amongst the Ordinary Shareholders in the form of one new Ordinary Share for every existing Ordinary Share.

I should like to emphasise that this does not imply any intention to increase the amount distributed to the Ordinary Shareholders for 1960.

The report and accounts were adopted.

At the subsequent extraordinary general meeting the Board's capital proposals were duly sanctioned. B 970

Companies

Success and a Difficult Year

With a new factory to equip and start up and with new gear being brought into production, 1960 is a difficult year, but not less profitable than last, for the electrical engineers SWITCHGEAR AND COWANS Limited, of Manchester.

1959 was by no means an unprofitable year. The profits rose by 27 per cent to £242,318, an improvement both in the parent and the subsidiary companies.

The work and stock in progress of the company were both lower than a year ago—because the introduction of new gear made it necessary to keep the lowest workable stocks in order to keep down the write off. With a very satisfactory order book the works are expected to be busy throughout the year.

In other fields the company will also be busy. As a means of coping with the increasing demand the company's development site at Broadheath is being brought into use. A 70,000 sq. ft factory is going up. The estimated cost, with cranes, lighting, heating and fixtures will be about £150,000.

In the field of the company's technical progress, the range of medium and high voltage designs has been proved and pilot production begun. Tooling up is well in hand and the new gear has now to be introduced into production without adversely affecting the flow.

Massive Company Support for Safety Competition

The National Safety Contest—which offers a first prize of £500 for the best life-saving idea—is backed by 35 of the best known companies in the country.

As the number of road deaths, and the public concern, steadily increase, the active willingness of the directors of public companies not themselves directly involved to help mitigate the slaughter assumes the proportions of the effort made after great disasters.

The importance of the competition is well underlined by Mr. Ernest Marples, the Minister of Transport. Looking back over the road figures for his lifetime, Mr. Marples says: "In the last 50 years eight million people have been injured on Britain's roads and a quarter of a million killed. In the next 50 years, without any increase in the present rate, 15 million people will be injured and three hundred thousand killed."

One of the greatest dangers on the road is hardly removable by even the best of brainwaves. It is the bad tempered driver, the driver angry at others on the roads, or distracted by personal tensions.

Perhaps the winning idea will be one that could bring about greater use of existing safety measures. By now the benefit to the motor cyclist of using a crash helmet ought to be obvious enough. In a recent crash one motor cyclist was unconscious for 17 hours after being thrown to the ground. But he was wearing a crash helmet and was back to normal after nine days.

The original trust deed of the National Safety Contest was signed by the BRITISH OXYGEN Company and the DISTILLERS Company. The co-sponsors include Associated Portland Cement Manufacturers, the Beecham Group, Bowater Paper Corporation, British Motor Corporation, Cape Asbestos, Coca-Cola, Courtaulds, De La Rue, Esso Petroleum, Firestone Tyres, Arthur Guinness, Holland & Hannen and Cubitts, Kraft Foods, Marks and Spencer, Metal Industries, the Nestlé Company, Petrofina, Pressed Steel, the Pyrene Company, W. H. Smith and Son, Joshua Tetley, Transport Development Group, Whitbreads, John Summers and Sons, George Wimpey, British Nylon Spinners, Cammell Laird, Constructors John Brown, Chesebrough-Pond's, CAS Industrial Developments, Emu Wool Industries, Nu-Swift, and McVitie and Price.

Factory welfare and safety officers and local town halls have application forms for the competition. The trustees will be willing to give advice to winners who want to market their ideas.

Under the Influence

A prize winning safety idea will presumably start from understanding the cause of the accident. In the case of road accidents, *Roadcraft*, the police drivers' manual, says that the cause of nine out of ten accidents is the human element. The section titled, *The behaviour of a car under the influence of acceleration*, leads on to a definition of acceleration sense. The whole booklet, published by the Stationery Office at 3*s* 6*d*, is more than worth any motorist's study. What it says on acceleration is particularly important.

It is this sense that distinguishes the good driver, says *Roadcraft*. In practice it amounts to driving with constant allowance for speed of cars ahead and behind, road surfaces present and in front, safely overtaking slower vehicles where appropriate and being ready to decelerate when an "inconsiderate" driver overtakes and has suddenly to pull in.

Fifty Years of Sperry

Within a year of founding his SPERRY GYROSCOPE Company in New York Dr. Elmer A. Sperry had installed the first stabilising gyroscope in an aeroplane and had completed the first gyro compass, which was installed in the USS Delaware.

The company that developed with such precocious ability was founded 50 years ago this month. Since its early days it has been a leader in the development of modern marine navigation, aircraft navigation and automatic control, in electronic and precision engineering and in the guided weapon field.

As far back as 1915 the company had a hand in a guided weapon, a robot aircraft with an explosive warhead. It was flown successfully.

The zest behind the Sperry development came at first from the prolific Dr. Elmer who took out over 400 patents and brought a dozen companies into existence.

In the United Kingdom the SPERRY GYROSCOPE Company Limited was incorporated in 1915, two years after the Sperry company had begun activities in Britain. It has added industrial instrumentation and control to its operations in the marine, air and guided weapon fields.

BOAC Makes Record Operating Profit

The furious pace of increase in airline carrying capacity was sharply indicated in some figures given by the BRITISH OVERSEAS AIRWAYS CORPORATION chairman, Sir Gerard D'Erlanger (inset),

in his cheerful summary of BOAC's profitable 1959.

Last year the capacity of the Corporation increased by 29 per cent over the year previous. Intensive publicity, an aggressive fares policy and rising business activity combined to raise the "carryings" by 29 per cent too. For 1960 the carrying capacity will be up by 42 per cent, largely as the result of the much bigger, faster Boeing 707s.

Unit costs and break-even loads are being substantially brought down by energetic management efforts within the Corporation. This and the introduction of the ROLLS-ROYCE Conway engined Boeings, allied to the programme of fare cuts over a wide range of services, should go a long way to keep up BOAC's profitability this year.

The provisional figures show an operating profit of £4 million, reduced to a true profit of £100,000 after payment of fixed interest. This is better than the previous year's effort by almost £2,250,000. The associated companies have further to go to break into the black. They lost £1·1 million, after payment of interest, which is very nearly £2 million less than the loss in the year before.

Swings and Roundabouts for Joints and Shafts

As the length of motorways in the United Kingdom increases so the demand for overdrive on quite modest saloons will grow. A recent example of this has been the introduction as an optional works fitted extra of the Laycock De Normanville overdrive on the Vauxhall Velox.

The company who manufacture this mechanism, and who stand in the direct line to benefit from this trend, are BIRFIELD Limited, whose annual report, which happens to extend only as far as 31 July last year, is able to state that demand for the group's highly diversified products has never been so robust.

Mr. H. E. Hill, the chairman, describes the past year as in many ways one of the most difficult in the whole Birfield history. Propeller shafts, an important part of the group output, were being sold at "unremunerative" prices although these have now been increased to a level yielding a satisfactory profit.

The operations of the subsidiary PHOSPHOR BRONZE Company at their Birmingham foundry made serious losses but the business was moved to the Birfield foundry at Rochester, Kent, and good progress is now being made towards profitable operation.

Mr. Hill looks forward to profitable employment for the greater productive capacity which springs from the heavy investment in recent years for bringing on new products. Another £3 million is to be invested in this way over the next two years.

The trading surplus for the year, £919,797, was 25 per cent down on the previous year when the surplus was £1,227,093. The position has already been immensely improved this year when the trading surplus up to 31 January has increased to £1,013,000 from a surplus of £342,000 in the first six months of 1959.

For the propeller shaft producer HARDY SPICER, virtually the makers to the whole British motor industry, there is a serious implication in the two BRITISH MOTORS baby cars with their front wheel drive. Mr. Hill forecasts that front wheel drive may spread to cars of engine capacity up to 1½ litres. This is not good news for makers of conventional propeller shafts, but for Birfield group as a whole what matters equally is that some years ago it bought the manufacturing right to the Rzeppa constant velocity joint.

The Rzeppa joint is used on both the BMC babies and the group can well claim that this product has a sparkling future at home and overseas.

The widely spread Birfield industries would benefit from a summer which repeated last year's sunshine figures in other ways as well as through increased motoring. Through its companies, T. B. FORD, of High Wycombe, Buckinghamshire, and INTERMIT, Birmingham, the group meets the filtration demands of brewers, distillers and soft drink makers.

Awake to the need of having a foothold in the European Common Market, the group has bought a quarter of the share capital of the German propeller shaft concern GELENKWELLENBAU, of Essen. It also has a 20 per cent holding in GLAENZER SPICER SA, in France.

Vigorous Growth of Chemical Facilities

Matching the increasing rate of expansion in petro-chemicals is the rising cost of research and development in the industry.

The annual report of the United States UNION CARBIDE CORPORATION shows that the cost of research and development last year rose to $79 million (£28 million). In the year before it had been $71 million.

The corporation maintains 26 major research laboratories employing several thousand qualified staff.

The overseas interests of Union Carbide account for a good deal of the firm's growth. Its manufacturing companies outside America have doubled their sales in five years.

Among the overseas expansion plans is the new chemical plant, costing several million dollars, at Ponce, in Puerto Rico. This is operated by UNION CARBIDE CARIBE Incorporated, a subsidiary. Other affiliated companies are this year to complete additional chemicals and plastics plants, in Italy and India.

Beryllium Metal Sections in Production

Beryllium metal, first used in nuclear engineering, has properties which make it attractive for many other purposes. Tubes and sections are already in production, and further developments are proceeding.

ALTHOUGH its existence was known as long ago as 1797, beryllium remained, until recently, little more than a curiosity. For some years it has been used as an alloying material for copper, but it was only when certain of its unusual properties made it a highly desirable material for fuel cans in nuclear engineering that it was produced in metallic form. But apart from its special nuclear properties (a remarkable ability to pass neutrons—it has been described as virtually "neutron-transparent"), beryllium has a wide potential in other engineering fields. In some ways beryllium is today in the same position as aluminium was not so very many years ago, though its physical and metallurgical properties are very different. Aluminium presented some weighty problems in the early days, but they were all solved. Stronger than steel and only a quarter its weight, with very high corrosive resistance, and retaining its strength at high temperatures, beryllium could solve many design problems. Two examples of its potential will suffice. For aircraft structures its strength-weight ratio is particularly attractive, and for rapidly rotating parts such as the compressor blades of gas turbines, low weight and high strength offer equally important advantages.

The disadvantages of beryllium at present are its high cost (largely a function of the small production rate); the fact that special and costly techniques are needed to make and to fabricate the metal; and the problem of directional ductility; at room temperature it is highly directional and very brittle. It can only be bent or shaped with difficulty (other than by machining) at room temperature, and if it is heated above 750° C special precautions are necessary to prevent contamination by oxygen, for which the metal has a great affinity. In addition, the metal in divided form has a toxic hazard. Such are the main problems encountered in dealing with beryllium as a metal. Some of them have already been solved, wholly or in part, and others are being actively investigated.

It was with the general engineering applications of beryllium, as well as its nuclear power uses, very much in mind that Tube Investments Limited first started to investigate the problems of berryllium fabrication. Laboratory-scale experiments having proved successful, a pilot production plant has now been installed at Tube Investments Technological Centre, Aldridge, Staffordshire. It is the first British plant to produce, in quantity and to customers' orders, precision tubes, rods, flats and sections of beryllium with guaranteed properties. Designed and built by the TI Technological Centre in the short time of six months, the pilot plant occupies some 6,000 sq. ft, and has a planned production of ½ ton of beryllium tubes and sections a year. The present range of products is shown in the appended table.

GRAIN CONTROL

At an early stage in the investigation of beryllium properties it was thought that ductility at room temperature could be improved by persuading the metal to crystallise in a large number of small grains instead of a small number of large ones, which would be the case if the metal were melted and allowed to solidify normally. Consequently, production is based on compacting and sintering finely ground metal into the form required for subsequent processing into the finished product. This has a beneficial effect on the ductility, but the extent to which it can be carried out is limited, and further developments are likely to be in the matter of grain orientation control; some success has, in fact, already been achieved in this respect.

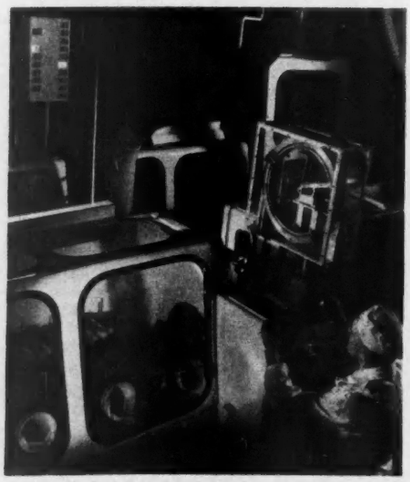
Production at Aldridge starts with high-purity beryllium powder (−200 mesh) which is received, at present, from the USA. It arrives in sealed cans containing 5 lb each. Because of its toxic effects, precautions have to be taken against the possibility of its being breathed by the operators or entering the body via breaks in the skin. It is also highly sensitive to oxygen. For these reasons, special handling and production techniques are necessary which involve the use of glove boxes, vacuum furnaces and special containment of fabricating equipment, the principles of which are well established.

In the sinter production building there is a series of glove boxes, interconnected by a sealed conveyor which enables each stage in the process to be carried out in turn behind transparent

Continued on next page

Machining is done in cabinets under air suction.

Beryllium is sintered in electric furnaces. The top of one furnace is visible below the vertically arranged charging glove boxes.



A sealed conveyor (centre) connects all the glove boxes in the hollow and billet production line.

Present range of beryllium cross sections and lengths.

Section	Internal dia. (in)	External dia. (in)	Wall thickness (in)	Length (ft)	Remarks
Tube	¼ to ⅞	—	0·016 upwards	Up to 17	Typical diameter dimensional limits on 0·300 in i.d. × 0·040 in thick walled tube would be ± 0·008 in on bore diameter on tubes up to 17 ft long. Closer limits can be obtained on shorter tubes
	Tubes having bores greater than ⅞ in can be extruded with a wide variety of wall thicknesses. Minimum wall thickness increases with increasing diameter				
Rod	—	⅛ to 2½	—	Up to 17	Longer lengths will be considered
	—	2½ to 5	—	5 to 17 depending on diameter	
Flats	To customers' requirements			17	Other simple configurations such as T's and angles can be produced
Finned tubes	0·3	0·5 over fins	0·04	5	18 fins each 0·060 in high in experimental lengths only at present

screens, completely sealed from the operators. The first stage in production is to enter the sealed cans into the system, and this is done through the first glove box, which has an entry lock through which the cans are passed manually. Checkweighing is carried out, to provide a basis for production yield figures, and the cans pass to another glove box, where they are opened, and the contents of six cans are emptied into an Apex "Y" cone blender. This blending of batches 30 lb at a time ensures uniformity of product. After blending, the powder is discharged to a tared container on a weighing machine where it is weighed into small batches of about 130 gm; the actual quantity depends upon the ultimate product required. Each batch is next vibrated into a mould of high-purity, reactor-grade graphite, the moulds passing via the conveyor to a glove box where a small quantity of beryllium oxide is applied to the surface of the powder, to act as a refractory seal. Filled moulds can be stored in this glove box if required, and there is provision for the application of argon to this box, and also to the blender glove box for air exclusion during shut down periods.

Moulds proceed from the storage glove box, along the conveyor, to one of three vacuum furnaces, with extended glove boxes above them for charging and discharging. All the furnaces are the same, of 25 kVA rating, with a maximum temperature of about 1,200° C, and are exhausted by vacuum pumps to 0·1 micron. A refractory chamber in the furnace accommodates the moulds, which are placed manually through the glove box, on refractory plates carried by a rod of the same material. An overhead hoist enables the carrying rod and plates to be lifted from the furnace and lowered into position. Eight moulds constitute a charge, and when the furnace is sealed and under vacuum, a three hour heating-up period begins. This is followed by about 5 hours at maximum temperature, and the remainder of the furnace cycle (of 24 hours duration) is occupied by natural cooling, under maximum vacuum.

The shape and size of the mould depends on the product required. For tubes a graphite core is inserted in the mould, and a short thick sintered tube is made; this is called a hollow. For solid rods and sections there is no core, and a solid billet is made. Hollows or billets are taken from the furnace, when cold, in their moulds, and a simple fixture, in a glove box, is used to withdraw the sintered piece from the mould. A further fixture enables the moulds to be checked for re-use, and both moulds and products go on to the conveyor again, the moulds to the filling glove box, and the products to be loaded into Perspex containers. In these containers (one to each hollow or billet) the products are taken out, through a glove box lock, to pass on for further processing.

SHAPING

It is now necessary to work the short, thick, hollows or billets into the finished tubes or sections. As this cannot be done at present by normal rolling or drawing methods, they are extruded. This is done at the works of the Chesterfield Tube Company, another TI Group Company, where the heavy hydraulic presses needed were already in existence.

But first, the sintered product has to be prepared for extruding, which is done hot (at a temperature of about 1,000° C or more). Because of the danger of oxygen contamination when hot, the billets or hollows are completely enclosed and sealed in steel "cans" before extruding. To prepare the sintered product for canning, it is first machined on the surface to size it accurately and to remove any trace of oxide and contamination. The billet or hollow is then placed in a suitable steel can. Steel ends are welded on, thus sealing the beryllium completely, and the cans are sent to Chesterfield for extruding. This is done by normal methods, in horizontal presses, the cans being first heated in a gas-fired furnace.

After extrusion, the sections or tubes are returned to Aldridge, still in the steel sheaths, which have been extruded with them, and the steel is removed by pickling in a 50 per cent concentration of nitric acid. It only remains to cut the tubes or sections to the lengths specified by the orders and to carry out any further sizing or straightening operation which may have been called for. In the case of tubes this may involve internal sizing, which is done by drawing a plug through the tube. It should be added that although it is possible, and in some cases necessary, to work to close tolerances, there are instances where slightly lower dimensional tolerances would be equally suitable. When this is so, the finished product cost can be reduced considerably.

MACHINING

As already mentioned, the hollows and billets are machined on the surface before canning. After extrusion, the tubes or sections have to be cut to length, and other machining operations may be specified by the customer. It is quite feasible to carry out any normal machining operation on beryllium, which presents no special problems from the mechanical cutting point of view. Orthodox machines and tool materials are used. Beryllium does, however, machine in a manner somewhat similar to cast iron; it cuts in small chips, and produces a certain amount of dust. It is therefore necessary to enclose the machines, to prevent the dust from coming into contact with the operators.

At Aldridge there are three barriers protecting the operators. There is a physical barrier in the form of a cabinet surrounding the machine, with windows to give a clear view of the work in progress. Air at high velocity is drawn over the actual point where the machining takes place, and the whole of the interior of the machine cabinet is kept at a lower pressure than the shop atmosphere. The air drawn out of the cabinet and across the point of machining is filtered and the dust extracted for safe disposal. Machining is, in fact, carried out in a modification of the glove box technique, though built-in rubber gloves are not provided or, in fact, necessary. Operators wear rubber gloves, and at no time can they come into contact with the dust. Finally, the entire department is air conditioned, and constant checking of the air is carried out.

Epoxide Moulds for Boat Building

The first application of large expoxide resin moulds in the building of boat hulls has been marked by the introduction of a new all reinforced plastics cabin cruiser made from glass fibre reinforced polyester resin. The Palmcraft, as the boat is called, has a top speed of approximately 18 knots when fitted with a Ford Sea Consul engine and is being produced by Palmers Reinforced Plastics Limited of New Beckenham, Kent, a member of the Thomas Tilling Group. The boat is 20 ft long with a beam of 7 ft 6 in.

The hull is produced in one piece by spraying glass fibre and Bakelite polyester resin on the inside of a mould based on Bakelite epoxide resin. With a moulding surface of just over 430 sq. ft, this epoxide mould is claimed to be one of the largest yet produced and, although initially more expensive than the more usual polyester type of mould, its extremely hard, smooth surface enables it to be used in the production of a very large number of hulls. Normally, polyester moulds for boats of this size have to be treated after each lay-up with release agents: epoxide moulds require only wax polishing.

To make the large epoxide mould, a wooden hull was first built to the required design and the surface filled and polished to provide the necessary smooth finish. This was then used as a pattern for the production of a one-piece female mould, made from fibrous plaster. The wooden hull was removed, and after the plaster mould had been sealed and given a surface finish, a reinforced polyester hull was laid up inside by the normal hand lay-up technique. This hull was allowed to remain in the mould until fully cured and the plaster then broken away.

This first polyester resin hull was then braced internally and underwent a series of rubbing down and filling operations until the external finish was completely free from blemishes. To achieve the best possible finish, the surface was given a final coat of a polyurethane preparation. The epoxide mould was laid-up by hand on the outside of the polyester hull: the gel coat being filled with a finely ground slate powder to give a high degree of surface hardness. Mould rigidity coupled with lightness were obtained by the application of a layer of a Microballoon phenolic spheres mixed with Bakelite epoxide resin, and the mould finished off by the application of a suitable glass cloth reinforcement. A metal cradle was bonded into position on the mould before its removal from the die.

The decking, cabin top and superstructure are made in large sections from glass fibre reinforced polyester resin. All the component parts of the boat can be pigmented to suit the purchaser.

(Below) The epoxide mould used in the production of the Palmcraft.

(Right) The decking, cabin top and superstructure as well as the hull are made from plastics.

Data on Reliability of Digital Computers

How reliable are digital computers? What maintenance do they need? A conference was held recently to discuss these questions, and the conclusions are summarised here.

By J. K. Webb

Standard Telecommunication Laboratories Limited

ONE of the most significant technological advances of the past 20 years has been the development of data processing systems employing digital computers which, although now essentially electronic in character, still include mechanical accessories. As the capital cost of many such systems is high and the effects of interruption of services, or failure to give the right answer can be very serious, questions concerning their reliability and accuracy are particularly cogent. Unfortunately, however, such questions can seldom be answered categorically, since many conflicting factors are involved, and it is only recently that a firm general pattern of behaviour has begun to emerge. An attempt to take stock of the present position in this rapidly advancing field was therefore made this year by the British Computer Society and the Institution of Electrical Engineers, by arranging for those most intimately concerned, both manufacturers and users, to get together and discuss the various facets of the subject. A two-day meeting, held last January at the IEE in London, was attended by over 600 delegates, at which some of the problems associated with this difficult subject were ventilated.

COMPUTERS IN GOVERNMENT SERVICE

In the course of the meeting it was encouraging to learn of the systematic manner in which performance data on electronic computers introduced into Government departments are logged with respect to their reliability. Soon there will be 20 systems in operation, comprising 13 types derived from eight manufacturers. The method of collecting performance data, with their subsequent analysis and interpretation is in itself a very big subject. Much attention has been given to designing the most suitable information return forms, as these must be kept simple if they are not to become a burden and defeat their own ends. On the other hand, if made too simple, ambiguities can creep in. The information thus collected must be as significant as possible so that the nature of faults can be accurately analysed to enable suitable lines of action to follow. Such returns have revealed that for the type of equipment considered, something like 74 per cent useful time, 14 per cent routine maintenance time, 4 per cent lost time due to electronic faults, 5 per cent for other faults and 3 per cent unaccounted is the broad general picture which has so far emerged, although the degree of spread between similar installations has been a disturbing factor. Differences of as much as 20 to 30 per cent have been noted. Ancillary equipment gives more trouble than the main computer equipment. In connection with the figures quoted, an improvement of only 1 per cent in the useful time would save the taxpayer about £10,000 a year. It is felt that the present loss of 26 per cent of operating capacity is intolerable. For installations which will handle the proposed new graduated pension contributions for the whole of the country's insured population, the reliability should be raised to well over 90 per cent.

A distinction must be drawn between mathematical systems, including the foregoing, where final accuracy is more important than continuity of service, and telecommunication applications operating in real time, such as air traffic movement control, where the reverse is the case. A reliability factor of 90 per cent may suffice in the former case, but 99·9 per cent is still hardly good enough for the latter although to achieve this greater reliability may increase the cost by a factor of about ten.

COMPONENTS

There will inevitably be occasional failures of components in a computer, and precautions must be taken both to reduce their incidence and minimise their effect. Much patient work has been done on collecting statistical data on failure rates of electronic circuit components and their causes, both under controlled laboratory conditions and in ordinary service. Based on accumulated experience, typical probable failure rates per 1,000 hours in service are: capacitors 0·1 per cent, connectors 1·0 per cent, crystal diodes 0·1 per cent, potentiometers 0·5 per cent, resistors 0·2 per cent, switches 0·5 per cent, transistors 0·1 per cent, valves 1·0-2·0 per cent (depending on type). It should be emphasised, however, that these figures are distinctly pessimistic, and that considerably better results have been obtained on occasion. Moreover, the expression of failure rates in this way is an over simplification. While there is obviously much work yet to do to improve the reliability of components, the best must be made of things as they are. It would, of course, be possible to increase reliability by the testing and selection of components, but this is a costly procedure and only occasionally justified from the economic standpoint. Very special components are, for example, used in submarine cable amplifiers located at the bottom of the Atlantic. Under such circumstances the increased reliability warrants a tenfold increase in costs since the repair of a fault is a major operation.

ASSEMBLY

The question also arises as to how the components should be assembled. Soldered joints give a good deal of trouble and dry joints are often difficult to locate. The technique of wrapped connectors has provided an alternative showing excellent promise. Plug-in unit construction of circuits is now a well-established technique since it enables system faults to be cleared quickly, simplifies their identification, permits off-line servicing and improves accessibility. The reliability of such plug-in units however, depends very much on the quality of the plug-to-socket contacts which must be of a high standard. Direct comparisons which have been made between computers of conventional and plug-in construction have clearly indicated the superiority of the latter type.

Maximum reliability at a given cost, or alternatively, minimum cost for a specified reliability, is clearly desirable and one or other can be achieved by what is termed the statistical design of electronic units. It necessitates having certain statistical information about components which unfortunately is not yet readily available, but this is one of the deficiencies which must be overcome, particularly if mass production is envisaged. In the meantime, the theoretical approach has been developed.

MECHANICAL LIMITATIONS

It has become evident that the failure rate on mechanical accessories is considerably greater than that on electronic equipment so that the factors affecting the reliability of peripheral equipment must be carefully scrutinised. Fortunately, similar diligence has been applied to collecting statistics on the performance of mechanical systems as with electronic circuits and components. A disturbing picture is revealed; the reliability of peripheral equipment appears to be worse than the electronic equipment by at least a factor of three. It may be a truism to say, for instance, that the only thing wrong with a tape unit is the tape, but it does indicate that mechanical designers should aim at a higher degree of reliability than has so far been achieved. It was suggested that the next meeting should be held in conjunction with the Institution of Mechanical Engineers under some such title as "Why are the Mechanical Parts of a Computer so much Less Reliable than the Electronic Parts." There must indeed be much experience concerning mechanical structures which can be drawn from other fields, the aircraft industry for example, and imported under the right guidance into the computer industry. Alternatively, there is a move to replace by electronic devices purely mechanical equipment which, on account of its inherent inertia, cannot cope with computer speeds. One such example is the Xeronic high speed printer which is capable of printing at the rate of 5,000 characters a second or 1,500 lines a minute.

HUMAN ERRORS

It must always be remembered that a computer can only, at best, faithfully carry out the instructions given to it, and that these instructions are themselves subject to human error. The aim is (1) that the problem is properly posed, (2) that the selected method is one of the best of the possible methods, (3) that the machine receives correctly the data of the problem and the instructions for solving it, (4) that there are no undetected "blunders" in the course of the computation and (5) that the results are properly transcribed by the output medium. Instructions may be imparted to the computer by means of punched cards, or paper tape which can conveniently be sectionalised into short lengths of a few feet. Employing two girls to punch and verify tape, it has been found that the average error rate is about 0·003 per cent. Even this low error rate could produce chaos unless proper attention is given to it. Techniques have therefore been devised such as the use of redundancy and various cross checks so as to ensure accuracy and avoid delay.

Although for computers engaged in other than real time applications, occasional breakdowns can be tolerated, these will often occur at the most inopportune times. Arrangements must accordingly be made to ensure that their effects are minimised. Apart from local faults which can be quickly cleared, the possibility of catastrophic failure must be faced and safeguards devised.

Just as with human beings, so it is with computers that "prevention is better than cure." They can accordingly be kept in a state of good health by skilfully devised maintenance procedures which anticipate deterioration and institute remedial action. A form of "marginal" testing has accordingly been devised which involves varying the supply voltages above and below the optimum levels and applying such voltages progressively to various sections of the computer and noting the effects. In this way, potential weaknesses can be found.

On long data-processing runs where continuity is not essential, it is undesirable to have to return to the beginning of a calculation each time a computer fault develops. "Restart" points can conveniently be established at various stages so that, if a fault occurs, it is only necessary to return to the last of these points to complete the computation. Such restart points might be at the beginning of each output reel of tape, or every 15 minutes of operation.

Besides the customer's attempt to protect him-

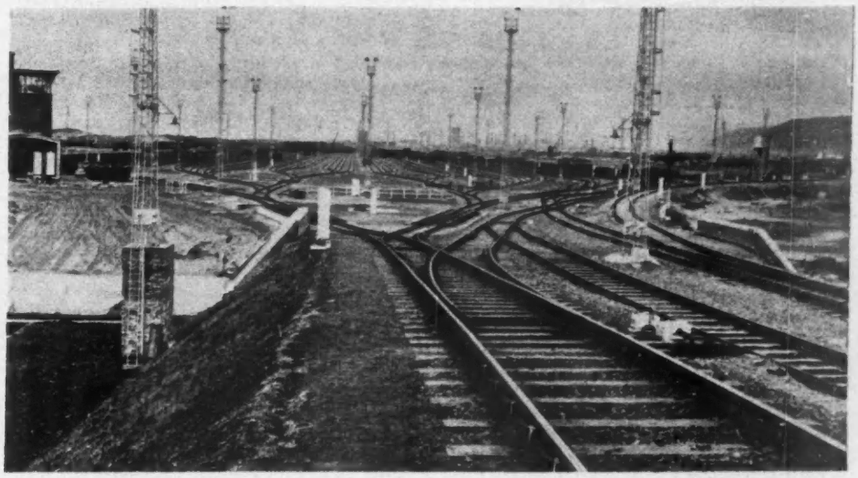
Continued at foot of next page

Speeding Rail Freight

Margam marshalling yard, South Wales, recently completed by British Railways, Western Region, makes extensive use of automatic control equipment, including radar and analogue computers. It is capable of sorting 4,500 wagons daily, and can deal with a total of 220 trains in and out in the same period.

The yard occupies an area of 178 acres on what was formerly waste sand dunes, and has 33 miles of tracks. Unsorted trains arrive at the reception sidings, where the wagons are uncoupled, singly or in groups, according to their destinations. A diesel locomotive pushes the wagons over a hump, and the points on the sorting sidings move automatically in response to a pre-set sequence. The weight and speed of each wagon or group of wagons is assessed automatically and progress is retarded to bring the wagon to rest at the point required.

Point setting originates with the shunter who divides the arriving train, and gives information by short-wave radio to the control tower. This information is set up on a perforated tape, and when the train is about to be humped, the appropriate tape is fed into a tape reader which sets the points automatically. As the wagons roll down from the hump towards the sidings, their speed is measured by means of radar and this information, together with other relevant data, is converted by computers into the action necessary to control the retarders at the track side and so to stop the wagons at the required points in the sidings.



When wagons roll down the hump at Margam, point setting and speed control are entirely automatic.

Other features include the repetition of the hump signal on a miniature apparatus in the actual cabs of the shunting locomotives, radio communication between the locomotives and the control tower and an extensive loudspeaker system, with microphones at strategic points to enable the staff to reply to necessary messages.

Lubricating Road Vehicles

The cost of lubricating a road vehicle, set out on a pence per mile basis, is very small indeed, and any gain which might be made by skimping it would very quickly be offset by the inevitable loss when mechanical damage occurred. To the actual cost of repair would have to be added the loss of revenue when a vehicle was off the road for the repairs to be carried out. So correct lubrication is one of the most vital features of any vehicle maintenance plan. Yet correct lubrication is not simply a matter of seeing that all the oil and grease points are kept filled.

So much depends on a film of lubricant which is seldom more than 0·002 in thick and is often only of microscopic dimensions, that the choice and proper application of the lubricant can be quite a complicated matter. Guidance on the subject of lubrication is available from the makers of the vehicles, who are very well aware of the importance of the subject. But their recommendations are usually limited to specifying grades of oil and grease, and periods at which attention is necessary. The basic principles of lubrication and its theoretical background are more appropriately dealt with by lubrication specialists. Wakefield-Dick Industrial Oil Limited, Marylebone Road, London, NW1, have gone into the subject at some length in the latest edition of their handbook "Road Vehicle Lubrication."

Fundamentally, lubricating oil is a means of separating two moving metallic surfaces, and preventing the interlocking action which would be inevitable if they were run dry. Oil has several easily determined characteristics of which colour is the most obvious; it is, however, of no value whatever in assessing quality or lubricating value. Neither has specific gravity much relationship to the essential qualities of oil, its main value being to show its weight/volume relationship, which is of interest to those who have to arrange for its storage and distribution. Pour point—the lowest temperature at which an oil will flow by gravity—is again of little value in quality assessment, but viscosity (which is often confused with pour point, but actually refers to the oil's resistance to flow or motion) is a very important characteristic. Flash and fire points, though of interest from a safety point of view, have little connection with lubricating quality. No single characteristic of an oil, in fact, is any criterion; many features have to be considered in relation to the work the oil has to do. Detailed specifications exist, but every application has to be treated on its merits. Petrol and diesel engines have different operating characteristics and, incidentally, the driver can help the lubricant to do its work by intelligent handling of his engine. Gearboxes, clutches, transmissions, torque converters, suspension, all pose different lubrication problems. Suitable lubricants are easily obtainable, but they can only succeed if the right one is used in the correct way.

Given the correct lubricant and its application in the recommended manner, is there anything further to be done? There are quite a few lessons to be learned from examination of parts when a vehicle is in the repair shop for routine maintenance. Some wear is inevitable, but the qualified engineer will distinguish between that which derives from normal usage and that which is due to imperfect lubrication. If the latter condition appears, the remedy is obvious. Mechanical imperfection, too, can have effects which are not infrequently blamed on lubrication, and these can be detected by examination of the parts when the engine is dismantled. Here, again, the remedy is obvious.

Finally, there is the question of the equipment used in the maintenance shop. A well-thought-out and properly equipped lubricating bay, with proper lubricant storage facilities, is of prime importance if the routine work is to be carried out effectively.

Concluding **Data on Reliability of Digital Computers**

self against inferior equipment and human error, progress can be made towards greater reliability by his adopting a cooperative but critical attitude towards the supplier. Manufacturers have an unenviable task, since reliable equipment, which embraces many disciplines, can only be produced after the expenditure of much time and money. Compromises have to be made to sell new models in the face of keen competition. Nevertheless, reliability should govern market policy and wherever possible no equipment should be sold until it had been fully tested and proven by comprehensive field trials conducted by independent teams. For example, in the relations between the GPO and its contractors, new systems are usually vetted by Post Office engineers before the design is finally approved for production.

CONCLUSIONS

This very brief outline of the course of the meeting can do little to convey the range and depth of the topics covered, or the facts and feelings which emerged in the course of the discussions. Such meetings are frankly experimental in character, and represent a new departure in an attempt to find the best way to disseminate information in a rapidly developing subject such as the present one. Only brief synopses of the various contributions were at the time issued in pre-print form, but authors have now revised and expanded their themes. The revised versions, together with edited accounts of both oral and subsequent written contributions to the discussion, will appear in a publication to be issued jointly by the BCS and the IEE by June of this year. Names of authors and the organisations they represent will be given. Those taking a special interest in the subject will thus have the opportunity of studying it in detail.

On the Shelf

By Frank H. Smith

ONE gets so many folk who read the column and take a delight in pointing out the bloomers that it's a relief to find someone who obviously does *not* read the column. On 4 July, 1958 (a month after their first publication), I gave a little splurge to the Water Pollution Research Laboratory's (DSIR) new *Notes on Water Pollution.* (Perhaps I should have said splash instead of splurge.) Now, with No. 8, March, 1960, they send us the set asking if they have ever been mentioned in the Shelf (on the Shelf? under the Shelf?). Well, they have and they are now—again. The latest title is "Sampling Natural Waters and Polluting Liquids" with nine references.

I learn from a paper "Human Body as an Inconstant Heat Source and its Relation to Determination of Clothes Insulation" (*Journal of Basic Engineering*, March) that Gagge, Burton and Bazett defined the "clo," a unit of thermal insulation of clothing, as the amount of insulation necessary to maintain comfort (a mean skin temperature of 92° F) of a resting subject in a room at 70° F with air movement of 20 f.p.m. humidity not over 50 per cent with a metabolism of 50 kilocalories (Kcal) per square metre per hour. Which strikes me as being a hell of a lot of trouble to get one clo.

The Heat Division of the National Engineering Laboratory (used to be MERL) has produced "Heat Bibliography 1958" This is an HMSO at 15*s*. 280 pages are divided into 51 subject headings in turn sub-divided. This is the fifth of a series and the first for which charge has been made. The editor modestly says these are only the references that have been noted in the NEL but I imagine if they can whip up 290 pages they cannot have missed an awful lot.

In November, 1958, an International Conference on Scientific Information was held in America. If you have not heard about this and still want the two volumes of the *Proceedings* (1,635 pages, 75 papers, 250 pages of discussion) they cost $20 the two from Printing and Publishing Office, National Academy of Sciences—National Research Council, 2101 Constitution Avenue, Washington, D.C., and I like to think that somewhere in that lot is a paper saying that there are too many conferences.

"Microtexts as Media for Publication" is a booklet obtainable from G. H. Wright, the County Technical Librarian of Hertfordshire (Hatfield Technical College) and it is the printed version of the papers and discussion of a symposium held at the college last November. This one costs 9*s*, which is more expensive than the booklet giving the griff from the previous meeting on the same subject in which, by the way, Mr. Wright seems to be quite the specialist.

The University of Illinois Library School produces *Occasional Papers*, of which No. 57 (December, 1959) is "An Appraisal of Favorability in Current Book Reviewing." It arises out of an impression that reviewers rarely slate a book (which is quite true of course) and they have gone to all the trouble to read hundreds of reviews (US, of course) and rate them according to a certain coding.

The latest list of US Govt. publications lists three new Library of Congress schedules, Class B, Part 1, at $1·75; Class L at the same; Class U at one dollar.

Dawsons (16 West Street, Farnham, Surrey) do a leaflet on their reprint of the *Phil. Mag.* They cover 1948-52, so if you want any of them send for the leaflet.

Its audience must be very limited but *Fiat Aviazione* now does English and Italian in side-by-side columns. Up to 1960 they simply put in an English abstract insert. The new one is much more convenient but not nearly so funny because they now evidently have a translator who knows English.

Freezing Cycle

Automatic Refrigeration. By S. A. ANDERSEN. *MacLaren and Sons, 131 Great Suffolk Street, London, SE1, for and on behalf of Danfoss, Nordborg, Denmark.* (85*s*)

Refrigeration Manuals. Volume 1: Refrigeration Educational Course. Volume 2: Common-Sense Talks on Commercial Refrigeration. Edited by the Editor of *Modern Refrigeration and Frozen Foods. Refrigeration Press, Maclaren House, 131 Great Suffolk Street, London, SE1.* (15*s each*).

In the preface Professor Andersen states that his book *Automatic Refrigeration* emphasises two subjects, automatic control and the relative humidity of air. This does not mean that he neglects other aspects of refrigeration. On the contrary, this considerable volume covers a very wide field and is in some measure unique in that it does not describe the basic theory of the refrigeration cycle itself, as do most text-books on the subject, but deals with many of the ancillary subjects of importance to both the student and the practising engineer. In this respect it fills an important gap in the rather limited range of refrigeration publications.

The book begins with a survey of the aims and principles of refrigeration. This includes some basic theory of psychrometry, fluid flow and vapour pressures, followed by illustrated descriptions of heat-exchange apparatus, plant systems and compressors. The introduction to automatic control discusses the principles of this subject as it effects the refrigeration engineer in a more clear and detailed manner than hitherto published. This section culminates in a series of excellent coloured sectional drawings of control valves, thermostats and pressurestats accompanied by an analysis of their functional principles. The fact that the articles described are predominantly those made by the Danfoss Manufacturing Company who sponsored the book does not detract from their usefulness as they are generally representative of their kind throughout the world. A further section deals with the many applications of refrigeration and these are illustrated by photographs of plants and buildings. Some useful tips on various design points are included.

The second half of the book might almost have been published as a separate volume for it has little in common with the first half either in content or presentation. It mainly comprises a series of calculation sheets in which the calculations from basic theory for heat-transfer coefficients, compressor performance, fluid flow, heat loads and much more are described in detail and illustrated by worked examples and diagrams. This section is of particular interest to the plant designer, as practically all he needs is grouped here in an easily understood form. Much useful data is tabulated at the end of the book. This includes conversion tables, meteorological data, physical and thermodynamic properties, primary and secondary refrigerant data, and considerable information on the freezing and storage of foods, and the design and layout of equipment.

References are quoted throughout the text and are also indexed in a section which enables one to explore further any particular source of information. A separate pocket folder contains psychrometric charts and pressure-enthalpy charts in both English and Metric units for all the normal refrigerants.

On the whole the book is quite readable, although the fact that English is not the author's native tongue is apparent in an occasional stilted phrase, and some of the expressions used are not those to which we are accustomed. The general presentation of the book is excellent and the phtotographs and line illustrations are of a very high standard. In particular the method of page layout, which places all diagrams in a broad margin thereby leaving the text free of interruptions, merits favourable comment.

This is an unusual book in that it does not follow the style of the conventional text-book. It gives us the opportunity of benefiting from the knowledge and experience of a man who has devoted almost a lifetime to furthering the science of refrigeration. It is, I feel, particularly useful to the student who is taking a comprehensive refrigeration course to a high standard, but those already in the industry in the field of plant or component design will find much to interest them and will welcome the second half of the book as a standard reference volume.

This will not be the case with "Refrigeration Manuals" compiled by *Modern Refrigeration and Frozen Foods.* These booklets are intended for the less technical reader; the serviceman, erector, plant engineer or junior student who wishes to learn something of the theory of refrigeration without becoming involved with complicated formulae and diagrams. *Manual-1* entitled *Educational Course* assumes that the reader has some experience of industrial plant and sets out to teach, in as simple a manner as possible, elementary heat laws and the theory of the vapour compression cycle. It describes the advantages of multistage compression for low-temperature work and introduces the reader to some of the factors affecting heat transfer. The plant engineer is advised on the methods of judging tenders from rival manufacturers with particular respect to obtaining a true balance between first costs and running costs. There is also a considerable amount of elementary information on the effect of humidity in cold storage on mould growth and bacteria action.

This booklet does suffer slightly from being reprinted from a series of articles which must have been published quite a number of years ago. It is decidedly out of date in several places, making no reference to the modern high-speed multi-cylinder compressor, and ignoring almost all refrigerants except ammonia and carbon dioxide. Also, for some reason, the flooded shell-and-tube multipass evaporator is described as an early method, presumably now never used, whereas, on the contrary, this type of evaporator is one of the most popular liquid-cooling units in use today. The presentation is not as good as it might be: the paper used is rather coarse with the result that line diagrams and sectional drawings lose some of their clarity. But for a practical engineer who wants to know something of what goes on inside the pipes, the manual is quite good and not likely to bog down the reader in a morass of high-faluting technological theory.

Manual-2, entitled *Common-sense Talks on Commercial Refrigeration* is definitely meant for the agent, serviceman or installation engineer dealing with plants in the ½ to 5 horse-power range. Again complicated theory is avoided and the reader is given the opportunity of understanding enough of the theoretical principles to appreciate the reasons underlying the design of plant components, such as evaporator coils, compressors, and small air and water cooled condensers. In particular the short exposition on compressor volumetric efficiency is very useful as also is the warning against accepting manufacturer's capacity tables without understanding fully the conditions on which they are based. A further section stresses the importance of water removal from plant components and describes in considerable detail a method of oven drying suitable for a service agent's workshop. There is also an excellent chapter on the relationship between service engineer and customer which emphasises many of the requirements of an efficient service organisation.

This manual is printed on a better class of paper than the other, perhaps made economically possible by the inclusion of trade advertisements on the back few pages. It is written in a straightforward chatty manner and is easy to understand. The only criticisms I can make are that methyl chloride is discussed more widely than I should have thought was merited by a refrigerant that surely is now becoming less popular. Also, why should a chapter on can-ice making be included in a book on commercial refrigeration? Why

not some descriptions of small automatic ice makers which would be more in keeping with what is otherwise a reasonably up-to-date publication. Apart from these fairly minor points this is a booklet that can be thoroughly recommended, especially to those employed in, or about to enter, the field of commercial service and installation work.

One further point worthy of note to potential readers of either of the " Refrigeration Manuals": they will be more useful if studied in conjunction with tables of thermodynamic properties of refrigerants which neither of them, because of their limited size, includes.

D. W. HIGHAM

Engineering Materials Reclaimed by Science

Growth and Perfection of Crystals. Proceedings of an International Conference on Crystal Growth held at Cooperstown, New York, on August 27-29, 1958. Edited by R. H. DOREMUS, B. W. ROBERTS and DAVID TURNBULL. *Wiley, New York; Chapman and Hall, London.* (100*s*)

Precipitation Processes in Steels. Report of a Conference held in the University of Sheffield 2-4 July 1958, and organised by the Department of Metallurgy. *The Iron and Steel Institute.* (84*s*)

Internal Stresses and Fatigue in Metals. Symposium held at the General Motors Research Laboratories. Edited by GERALD M. RASSWEILER and WILLIAM L. GRUBE. *Elsevier, Amsterdam; Van Nostrand, London.* (72*s*)

Almost the first application of the atomic hypothesis of matter was to the science of engineering solids. In the 16th and 17th centuries people speculated about the structures of crystals by comparing them with the patterns produced by stacking together hard spheres such as cannon balls in regular formations; and in the 17th and 18th centuries this hypothesis was used to discuss engineering materials and such things as mechanical working, fracture, alloying, and changes of crystal structure. The ideas then put forward, although extremely rudimentary, have since proved to be broadly correct.

But no one in those days could see atoms and this early attempt at a science of engineering materials failed to establish itself because it could not convince the sceptics. People learned instead to bypass the whole question of atomic structure by applying Newton's laws to hypothetical matter which was supposed to be featureless and continuous down to the finest scale of magnitude. In this way the sciences of elasticity and hydrodynamics grew up and became foundations of 19th century engineering. People learned, for instance, how to calculate the strength of a steel beam in terms of data gathered from simple tensile tests.

But what caused this strength, whether it could be increased, and why the material bent and broke at a certain applied load, were questions impossible ever to answer by this approach. The properties of matter had to be accepted passively and the energy of the engineer went into making the best use of them as they stood. This attitude became very firmly rooted and still dominates engineering to this day.

Atomic science and the strength of materials thus drifted apart, the former becoming claimed by chemistry and physics, the latter becoming an applied mathematics of hypothetical matter backed up by empirical data and experience. Only in the present century have they really come together again. The starting point for this was the metallurgist's microscope which revealed the fine crystal grains in metals and so made it possible to design alloys, and working and heat-treatment processes, intelligently in terms of the microstructure of matter. Then came X-ray analysis which showed the patterns of atoms in crystals.

But the ultimate steps, which have now turned the science of engineering solids into one of the most flourishing and active branches of atomic science, have come more recently. They are first, our greatly improved theoretical understanding of atoms and the way they behave generally, especially in solids; and second, the development of more powerful microscopic techniques which enable us to see individual atoms or very small groups of them in solids.

These new developments have completely transformed the situation and nowhere is this more clear than in the three books now under review. Each is a collection of papers and discussions presented at a recent scientific conference, and this, in itself, is an indication of the great activity now taking place in this field.

What also strikes the reader from these books is the decisive part that crystal defects on an atomic scale of magnitude, particularly dislocations and vacant atomic sites, are now playing in the subject. Without them a crystal is a frozen lifeless thing; with them it is full of ceaseless activity, with atoms migrating about, chemical processes going on both inside and at the surface, precipitates forming and redissolving, crystal planes slipping over one another by the movement of dislocations, and every crystal perpetually struggling to advance its boundaries into its neighbours.

Most structural materials are crystalline and the way that a crystal is grown largely determines its properties for the rest of its life. The growth and perfection of crystals is thus a logical starting point in the subject.

One of the most fascinating recent developments in crystal growth, which is brought out in the first of these books, is provided by whisker crystals. The study of these started as a purely practical problem, electrical faults in telephone boxes, but grew rapidly when it was discovered that these whiskers are the strongest forms of matter yet prepared. Iron whiskers, for example, have withstood stresses greater than 1,000,000 lb per sq. in without yielding or breaking. It seems fairly certain that whiskers will eventually be developed commercially to give us a new range of materials of exceptional strengths.

In a sense, the high strengths of fine crystals are already exploited in precipitation-hardened alloys, which rely for their strength upon the " keying " of slip planes by fine precipitates. The dislocations in those planes are blocked by the precipitates and these latter in effect have to carry most of the applied load. The development of precipitation-hardened alloys, especially creep-resistant alloy steels, has become a sophisticated business involving a detailed knowledge of the formation and properties of complex alloy carbides. The present state of knowledge about these and the important contribution of the electron microscope to this work is well brought out in the second of these books.

The two books just described are essentially for those who make engineering materials rather than for those who use them. Metallurgists engaged in the design of alloys, and applied solid-state scientists generally, will find them invaluable. The engineer, on the other hand, who is more concerned with the use of such materials will find the third book of particular interest to him because it deals with the behaviour of materials in service, namely, with effects of internal stresses and fatigue, and because it starts from an engineer's approach to the subject Dislocations and their properties are arrived at gradually as logical consequences of internal stresses in engineering materials.

All three books are to be widely welcomed. They contain a great deal of original work, as well as presenting the considered views of leading experts in the field, and will prove most valuable to all who are concerned with the science of engineering materials.

A. H. COTTRELL

New Books

Engineering Drawing with Worked Examples. By F. PICKUP and M. A. PARKER. Volume 1. *Hutchinson.* (21*s*)

The first of two volumes covering the work of the ONC course, but equally useful for City and Guilds and other syllabuses. The authors have presented the subject by means of worked examples, and have kept text to a minimum.

The Mechanics of Engineering Soils. By P. LEONARD CAPPER and W. FISHER CASSIE. 3rd edition. *Spon.* (30*s*)

A review of current soil mechanics theory and practice, revised from the previous edition to take in recent developments. The sections on stability of slopes and road design have been extended.

The Physical Metallurgy of Rolling. By F. H. SCOTT. *Arthur H. Stockwell Ltd., Elms Court, Torrs Park, Ilfracombe, North Devon.* (10*s* 6*d*)

An attempt to provide a theoretical background to a basic engineering process in a manner which, although advanced in places, should be easily understood by people in touch with the practice of rolling.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Materials

Asbestos Paper Insulations. TURNERS ASBESTOS CEMENT CO. LTD., Manchester 17. Eight page booklet covers manufacture, applications, features, technical data and availability of " Siluminite " asbestos paper and paper tape for high temperature electrical insulation.

Nickel Alloys. HENRY WIGGIN & CO. LTD., Millbank, London, SW1. Thirty-two page booklet is introduction to the company, its nickel alloys and their applications.

Melamine Plastic. BRITISH OXYGEN CHEMICALS LTD., St. James's, London, SW1. All about this plastic material; how it is made and how it is used for enamels, mouldings, textile finishes, adhesives and laminates.

Zirconium and Hafnium. IMPERIAL CHEMICAL INDUSTRIES LTD., Millbank, London, SW1. Eighteen page booklet gives concise details of all zirconium alloys made by this company and shows how they are being applied. Also gives the background to hafnium now being supplied for nuclear submarines.

Cast Irons. S. RUSSELL & SONS LTD., Bath Lane, Leicester. Leaflets on properties and applications of " Ni-Resist " and " SG Ni-Resist," and " Spheroidal." They are all nickel-cast irons, the second and third with spheroidal graphite, and the third only, with silicon.

The Reviewers

Mr. D. W. Higham, A.M.I.Mech.E., is assistant chief designer with J. & E. Hall Limited. He holds the City and Guilds Full Technological Certificate in the Science and Technology of Refrigeration.

Professor A. H. Cottrell, B.Sc., MA., Ph.D., F.R.S., is head of the Department of Metallurgy in the University of Cambridge. He is a member of the Institute of Metals, the Institution of Metallurgists and the American Society for Metals.

Marketing

Good Response at Utrecht International Technical Fair

A substantial demand for machinery, tools and apparatus was an outstanding element of the interest aroused by the Utrecht International Technical Spring Fair, held earlier this month. Many smaller and medium-size industrial firms were placing valuable orders, not only for expansion but for the replacement of existing machinery. Among the countries with whom business contacts were established in this section were Columbia, Finland, Western Germany, Belgium and Indonesia.

Business visitors attended the Utrecht Fair from 53 countries, a high proportion of them making contacts, or placing firm orders, in the building machinery and materials sector. In the internal transport section one exhibitor booked an order for 100 fork lift trucks. Export inquiries were received from Iraq, Iran, the United States, Canada, North Africa, Sweden, Luxembourg and Western Germany.

A much larger interest was shown this year in the air conditioning, heating, refrigeration and furnaces section.

EMI Cameras in Abbey Wedding Coverage

Up to 300 million people were able to watch the wedding of Princess Margaret in Westminster Abbey by television relayed through 13 countries coverage.

For their part in the day's reporting the Independent Television cameramen were using Image Orthicon cameras, by Electric and Musical Industries Electronics, working from the Abbey organ loft and using zoom lenses for close-ups.

The particularly significant feature of this camera for this job was that its pick-up tube can be replaced, in the event of failure, without recourse to opening the camera side covers. The replacement technique with the Image Orthicon camera is through its five-position turret.

Milford Haven Oil Storage tanks

The developments at Milford Haven in Pembrokeshire continue. One of the latest is the handing over to Esso at their refinery of nine 150 ft diameter storage tanks for crude oil, built by Whessoe, of Darlington.

Other tank storage capacity being built by Whessoe for the Milford Haven Esso refinery is approaching completion and two large high pressure storage spheres are almost ready.

Tungsten Carbide to be Produced in India

The setting up of a Swedish factory in India to produce tungsten-carbide bits and finished products will make a modest contribution to reducing the sub-continent's dependence on imported materials and tools.

The new works will follow the grant to the SANDVIK STEEL WORKS, of Sandviken, Sweden, of a licence to put up a factory 150 miles east of Bombay, at Poona. The cost of land, buildings and machines will be about £550,000.

Both Indian and Swedish capital is to go into the new company, SANDVIK ASIA Limited. Production is to start up in 1961. At first Swedish engineers will direct the plant and their Indian replacements will be trained there.

Sandviken already has factories in Europe, North and South America and in South Africa.

The "All-Industry" View at Hanover Fair

Epitomising the rise of Europe from unemployment and industrial collapse at the end of the war, the Hanover Fair rose from some disused buildings in 1947 to a commanding position among the contending world industrial fairs.

Comparative figures given by a member of the organising company, DEUTSCHE MESSE UND AUSSTELLUNGS AG, Hanover, show the leading position held by Hanover in the key matter of floor space provided for exhibitors.

With 4,700 manufacturing exhibitors and a rented exhibition area of 4,900,000 sq. ft the average exhibition area per exhibitor is 1,080 sq. ft. From official figures, it appears that Milan, with 13,000 exhibitiors had an average exhibition area per exhibitor of 170 sq. ft; Brussels, with 4,300 exhibitors, 270 sq. ft; Leipzig, with about 10,000 exhibitors, 315 sq. ft; and Paris, with 13,000 exhibitors, 375 sq. ft.

Since two years after its inception Hanover has been known as the German Industries Fair, uniting the consumer and capital goods sections since 1953. Certain of the most export-conscious sections of German industry have put up permanent buildings. The electrical interests have built themselves a three building complex giving a million square feet of exhibition space.

Seventy per cent of all exhibitors, including those from outside Germany, have rental agreements of 10 to 12 years.

An innovation at the Fair which draws particular attention is the "Economic Day." East Asia, Latin America and Africa (twice) have been the subject of previous days. This year the northern European states of Denmark, Finland, Iceland, Norway and Sweden are sharing an economic day.

With its own representatives in Europe and overseas and an impressive display of official information stands from over a score of other countries the fair merits, and receives, many serious visits and inquiries from the developing nations of Africa and other continents.

Its technical equipment is equally substantial. It has a railway freight station of its own and trains can run direct into most of the halls. Heavy duty road vehicles can run alongside the stands and in the two-storey halls of electrical industry and office equipment vehicles can pass up a 10 metre ramp to the second floor.

Fast travelling business visitors appreciated the frequent air taxi service between Langenhagen, Hanover's airport, and the fair ground.

First Durgapur Steel and a Pig Iron Record

Steel production has begun at the Durgapur steelworks, in West Bengal. The first open hearth furnace in the steel melting shop began work in the last week of last month.

The second furnace is ready for use and the third is almost complete.

Eventually Durgapur will have eight open hearth furnaces, seven of 200 tons capacity and one of 100. Together they will be able to produce 2,800 tons a day. Four additional furnaces have been allowed for as a later addition. The open hearth furnaces have been designed and built by the Wellman Smith Owen Engineering Corporation—a member of the thirteen-firm British consortium building the steelworks.

Production of pig iron from Durgapur's No. 1 blast furnace was over 7,100 tons in the week up to 10 April. This was the highest output of any week so far.

This School Opens Thirteen Hours a Day

One of the best of many films showing how individual firms have overcome special economic problems, in this case the need to produce buildings at speed at a time when the building industry's labour force is in decline, has been sponsored by BROCKHOUSE STEEL STRUCTURES of West Bromwich, Staffs.

The example taken in the colour film "On Schedule" is the attractive Tuxford Secondary School in Nottinghamshire, a good example of building by prefabricated sections. From the levelling of the site to the cladding and decoration, the methods used are demonstrated in the film and a final sequence shows how architects and manufacturers may combine to provide good buildings at lower cost.

A Brockhouse-designed school is to be demonstrated in July in Italy at the Triennale di Milano. The school was built in association with the Nottinghamshire County Architect's Department and members of the consortium of local authorities' special programme.

The school will be single storey, capable of taking about 100 children. It will have three classrooms, a hall, staff rooms, kitchens and the usual administrative space. Unlike most schools, this one will be open 13 hours a day from ten in the morning until an hour before midnight.

The weight of the building is carried on the steel frame, and since the components are pin-jointed the building is able to move with the ground, making it appropriate for use on sites subject to mining subsidence or other ground movement.

BOAC Receives its First Boeing 707

Happily coincident with the announcement of a profitable year, BOAC took delivery at London Airport of their first Boeing 707 jet airliner.

The full delivery programme will give the Corporation a fleet of 15 Boeings, 19 Comet 4's and 32 Britannia turboprops, one of the largest turbine-engined air fleets in the world.

All the BOAC Boeings should be delivered by the end of the year. They will have cost £45 million. Operating the vast leap between the RAF station, St. Mawgan, in Cornwall, and Seattle, USA, crew training is to begin next month. The target date for starting regular North Atlantic services between London and New York is June 6, with Canadian services following on June 15.

Pacific Partners in Expansion

The Australian expansion booms along and one of its most vigorous exponents has been drawing a parallel with Hawaii, Western Canada and other Pacific countries as "frontiers of opportunity."

He is Professor Sir Douglas Copland, an Australian trade mission leader who has been telling American businessmen that now is the time to go to Australia and develop the South-East Asia and South-west Pacific markets from there.

Sir Douglas might have continued his association as far as the fast growing eleven Western states of the USA. The extreme but logical development of the "Go west young man" philosophy might now imply a Pacific Ocean leap coming down in under populated Australia.

Business Exhibition Stresses Written Word

With a new production and a new export record for every year of the post war period, the office equipment industry is celebrating its still rising fortunes with the 47th NATIONAL BUSINESS EFFICIENCY EXHIBITION at Birmingham, opening on Monday, 16 May, at Bingley Hall.

105 firms are sharing 45,000 sq. ft of stand space and demonstrating not only new equipment and faster methods in the office but ways of giving a new and clearer look to every sort of office document. It is not lost on the strongly competitive business equipment industry that a firm's first appearance in many another's office is made on its stationery. And a bad first impression is only slowly erased.

Offset-litho printing machinery designed for the office, proportional-spacing typewriters with hair-line registration on both sides, and specially developed office photographic equipment, are some of the leaders among the exhibits.

A significant departure in the sales effort of the industry is its proposal to persuade professional men in practice on their own to use modern equipment and so reduce the time spent on clerical work.

CARSONS BROTHERS (PRODUCTIONS), of Basildon, Essex, are showing their range of CC desks designed for simplicity in use. The re-thinking of these desks has been carried right through to the omission of drawer handles, which have been replaced with a recessed moulding for finger grip. The centre drawer has also been omitted, to give greater knee room.

The exhibition has been organised by the OFFICE APPLIANCE AND BUSINESS EQUIPMENT TRADES ASSOCIATION. Many of the companies exhibiting at Birmingham manufacture in countries overseas in addition to their home activities.

Deodorant for Fishing Fleet

Very soon it will be possible to invite fashion writers to visit fishing vessels. At least to Norwegian craft, for the BRITISH PETROLEUM Company's associate, NORSK BRAENSELOLJE, has introduced a new disinfection and deodorising service for the fishing fleet.

The product used, BP Desomil, has been tested and approved by the Norwegian Research Laboratory.

The Stress Analysis of Railway Coaches

Established aircraft stressing technique can be applied to the design of a railway coach structure. Matrix algebra is used and the analysis performed on an electronic digital computer.

By A. H. Lucas

Norris Brothers Limited, Burgess Hill

EXISTING aircraft techniques of stress analysis can be applied to a railway coach structure which will give an accurate and detailed picture of the behaviour of the complete structure.

The method is that due to Dr. J. H. Argyris [1] and applied to aircraft wing and fuselage analysis [2, 3, 4]. It has been evolved to take advantage of the rapid arithmetic calculations which are possible using an electronic digital computer and is consequently built up using matrix algebra. To the analyst this means that all the initial information can be written in a very orderly fashion and hence easily checked.

It is not intended that this summary should explain the matrix-force method in detail, as this is expounded at some length in refs [1, 2, 3].

Briefly, in a structure built up of a finite number of elements, a column matrix S of loads, bending moments, torques, etc., on the individual elements is made up of $b_0 R$, which defines a " stress system in equilibrium with the applied loads (the basic system) and $b_1 X$, which is a self-equilibrating system resulting from the redundancies, to maintain the compatibility requirement. R is a column matrix of the loads applied to the structure and X a column matrix of redundancies, b_0 and b_1 define the geometric association between the elements and the applied loading and redundancies.

The unit load theorem is used to enable X to be found with respect to R and hence

$$S = b\,R$$

The computing of b constitutes the majority of the computer work requiring only the matrices b_0, b_1 and f, where f is a diagonal matrix of the flexibilities of the unassembled structural elements.

An extremely useful additional computation is used to cut out certain elements and yields a modified b matrix—b_c.

The work of the analyst, after suitable idealisation, is confined to the compiling of the initial data, i.e. the simple matrices b_0, b_1 and f, from which is computed:—

$$b = b_0 - b_1 (b_1' f b_1)^{-1} (b_1' f b_0)$$

and

$$b_c = b - b_1 (b_1' f b_1)^{-1} b'_{1h} \{b_{1h}(b_1' f b_1)^{-1} b'_{1h}\}^{-1} b_h$$

The chosen example is the coach depicted in Fig. 1 which has been designed on a simple basis consistent with common practice and with the desirable features of an integral design. As the coach is symmetrical, only ¼ of the whole structure requires analysis. A larger coach will involve matrices of higher order.

Two systems of static test loading are applied conforming with common practice. They are:—

(i) A distributed load R_v over the whole floor, grouped at the nodal points of the underframe grillage.

(ii) A buffing load R_h applied at the ends of the centre longitudes.

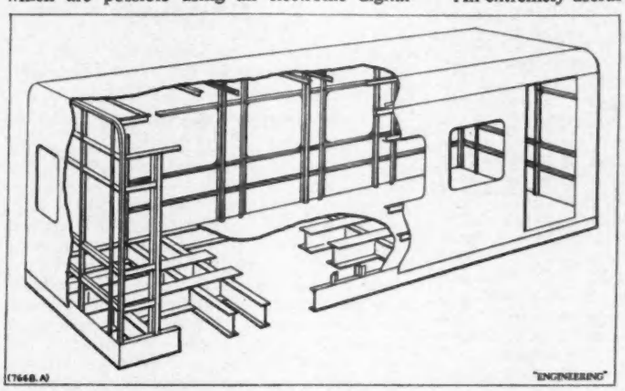


Fig. 1 (left) The coach structure.

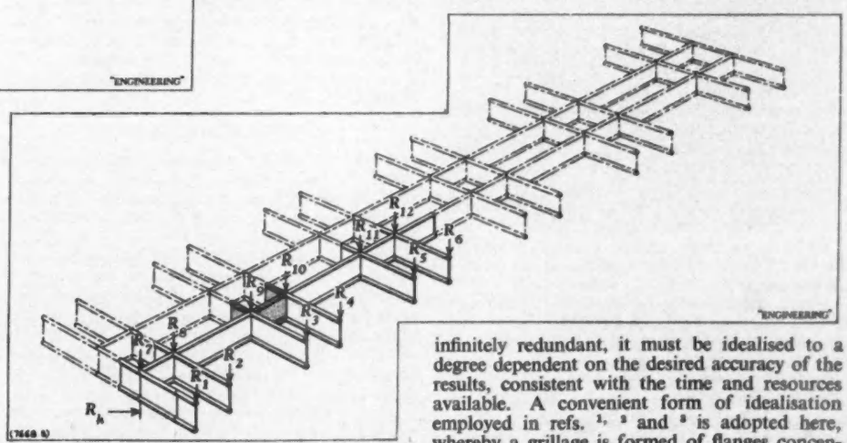


Fig. 2 (below) Loading of basic system.

IDEALISATION AND ASSUMPTIONS

As a stressed skin structure of this type is infinitely redundant, it must be idealised to a degree dependent on the desired accuracy of the results, consistent with the time and resources available. A convenient form of idealisation employed in refs. [1, 2] and [3] is adopted here, whereby a grillage is formed of flanges concentrated on the lines of existing structural members, enclosing shear panels representing the sheet material.

The function of the flanges is to transmit direct load. Therefore, although the flanges in the idealised coach mostly represent the actual structural members, their cross-sectional area includes a contribution from adjacent panels, as such panels carry a share of the direct load. Flanges are formed of sheet alone where necessary (e.g. the roof corner). The end load in the flanges is assumed to vary linearly between nodal points of the grillage and therefore two values are necessary to define the element, except where adjacent panels carry no shear.

The idealised panels carry only shear flow, which is assumed constant; their thicknesses and shear moduli are those of the actual skin of the coach.

To simplify the calculations the centre section of the bolster is assumed rigid. It is seen that the windows and the doorway are filled in with flanges and panels similar to those of the adjacent bodywork. This enables the minimum number of self-equilibrating system types to be used, resulting in regular and easily checked initial data.

The number of " stress values " in the structure

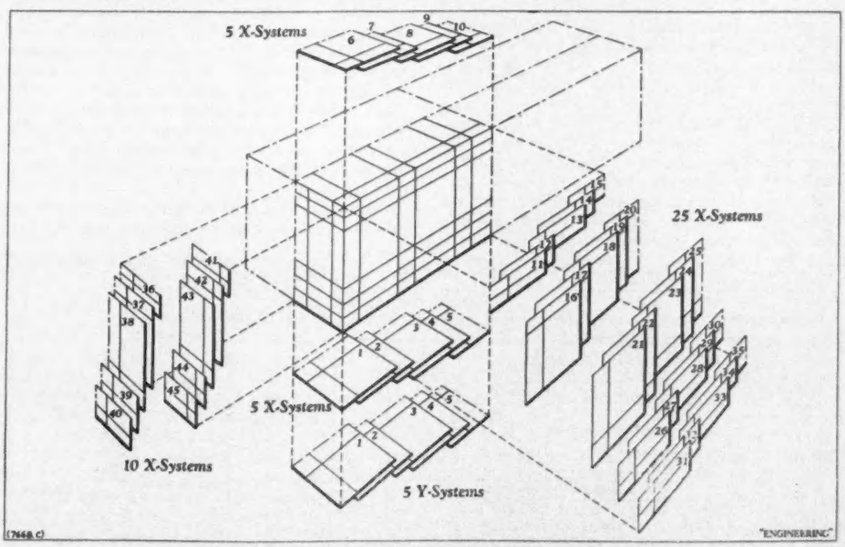


Fig. 3 Location of self-equilibrating stress systems.

Continued on next page

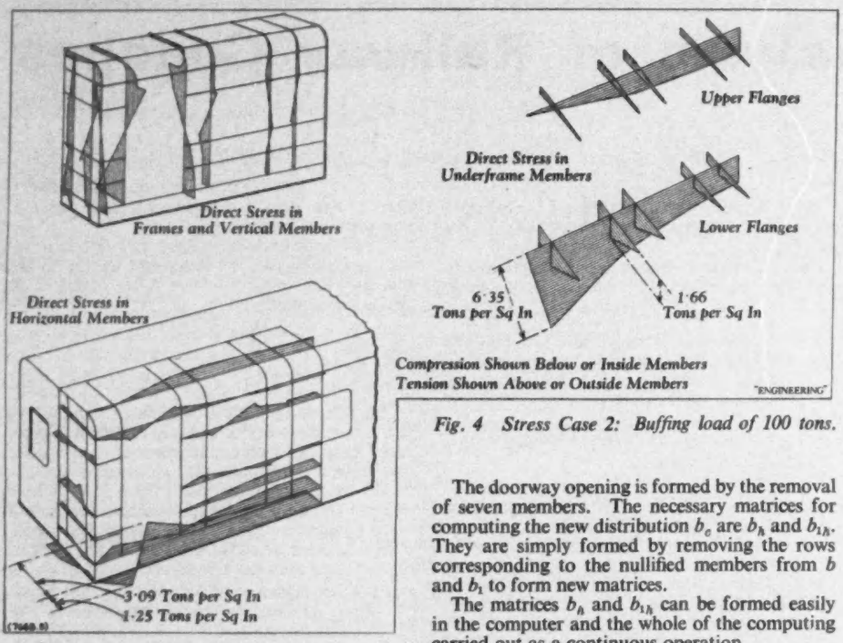

Direct Stress in Frames and Vertical Members
Upper Flanges
Direct Stress in Underframe Members
Lower Flanges
6·35 Tons per Sq In
1·66 Tons per Sq In
Direct Stress in Horizontal Members
3·09 Tons per Sq In
1·25 Tons per Sq In
Compression Shown Below or Inside Members
Tension Shown Above or Outside Members
"ENGINEERING"

Fig. 4 Stress Case 2: Buffing load of 100 tons.

to be determined is 327 (147 flanges and 61 panels). Thus the basic matrices b_0 b_1 and f, each contain 327 rows.

THE BASIC SYSTEM

The basic system need only provide a load path for the applied loads through the system, and the simplest possible statically determinate system is shown in Fig. 2.

The vertical loads R_1-R_{13} are repeated in all segments to enable the b_0 matrix to be compiled before taking out the quarter considered. Each load is applied in turn and flange loads and shear flows in the webs determined by simple statics.

This yields 12 columns in the matrix, but as R_1-R_{13} are dependent variables, they can be easily reduced to a single column, due to $R_v = 1$.

Similarly, a basic system consisting only of the centre longitudinals is sufficient to compile the column of b_0 due to $R_h = 1$.

The b_0 matrix is therefore 327 × 2, but only the first 65 rows of column 1 and the first 17 rows of column 2 require compiling and checking, all the remaining rows being zero.

In Ref. 1 is discussed the virtue of standard self-equilibrating stress systems. Basically, two types of system are employed here, the X-system and Y-system.

The X-system is similar to that of Ref. 1 but here it is only two-dimensional. Its function is to diffuse loads from one flange to its neighbouring flanges.

The function of the Y-system is to transfer bending moments from member to member in the underframe.

The application of the systems is shown in Fig. 3 where it is seen that 45 X-systems and 5 Y-systems are necessary, a total of 50 systems or redundancies. The b_1 matrix consists of 327 rows for the elements of structure and the number of columns is 50, that is, the number of redundancies. Simple arithmetic is sufficient to calculate the matrix elements, each of which defines the flange load or shear flow due to the self-equilibrating system governing the column.

The flexibility matrix specifies the elastic properties of the idealised coach elements and is a diagonal composed of single elements for shear panels and 2 × 2 matrices for flanges having varying end loads. The flexibilities are calculated with reference to the cross-sectional areas and lengths of flanges and the area and thickness of the shear panels. The size of the f matrix is 327 × 327.

COMPUTATION

The complete basic data, b_0, b_1 and f, is passed to the computer for the computing of b.

The doorway opening is formed by the removal of seven members. The necessary matrices for computing the new distribution b_c are b_h and b_{1h}. They are simply formed by removing the rows corresponding to the nullified members from b and b_1 to form new matrices.

The matrices b_h and b_{1h} can be formed easily in the computer and the whole of the computing carried out as a continuous operation.

The final results are b_c in the form of a matrix 327 × 2, the first column defining end loads and shear flows for a unit load, $R_v = 1$ and the second column likewise for $R_h = 1$. The loads chosen in this example are $R_v = 10$ tons and $R_h = 100$ tons applied to the whole coach. The calculation of S_c is simple matrix multiplication in the computer if R_v and R_h are known.

Fig. 4 shows the stresses for the buffing load of 100 tons.

SUTTER METHOD

A popular method of railway coach stressing employed today is that due to Dr. K. Sutter (Ref. 5), whereby the three-dimensional coach is transformed into a two dimensional system in the plane of the coach side (Fig. 5). The "side" is considered to be a Vierendeel truss, the upper chord consisting of material above the windows including half the roof, and the lower chord consisting of that below the windows and doors, including some of the underframe. The vertical members are the pillars of the coach. The geometry of the girder is determined by the positions of the neutral axes of the chords.

As the idealisation is considered to be more applicable to the vertical loading case than that of the buffing load, the total vertical floor load for one half of the coach is distributed along the lower chord of the truss and one quarter of the buffing load is applied on one half of the coach, as shown in Fig. 5. Only half the truss need be considered, which has eight redundancies. Ref. 5 illustrates the use of the elasticity equations of Muller-Breslau, which can be solved in the design office, but without a self-checking method it is far more economic to employ a computer.

The value of the unknowns, together with the loads in the primary system, yield the distribution of bending moments and direct loads throughout the truss. From the properties of the sections, stresses can be calculated at the extremes of the member forming the truss.

DEFLECTIONS

In designing an integral coach, due consideration must be given to deflection under vertical loading, especially when employing light alloys or other materials with a low modulus. Deflection figures are also of benefit to the builder in assessing the camber to be built into the coach side.

Critical deflection occurs in normal coaches at the centre line when loaded between the bogies, and if this is all the information required, it is reasonably expedient with the matrix force idealisation to calculate, from the S matrix, the bending moment diagram of members connecting the bolsters to the required deflection point.

For the rapid calculation of deflection of the chain of elements, a unit load is applied to the chain at the point of required deflection, which is given by:—

$$1 \cdot \delta = \Sigma \int M_Q M . ds/EI$$

where M_Q is the moment due to unit load.

In the same manner the deflection of the lower boom of the Sutter truss is calculated.

DISCUSSION

The application of the matrix-force method to an integral design of railway coach yields a pattern of behaviour previously unattainable without recourse to a long and expensive analysis. The greatest benefit to the designer is the number of stresses available throughout the coach, each one of which is a result of the behaviour of the complete structure. Such stresses are available at an early stage in the design and the structure can be subsequently modified and a new stress distribution revealed easily and quickly. The value of the modification technique is seen in this example, where regularity of the structure is achieved by filling in the doorways and windows and nullifying them later.

The results bear little comparison with those by the Sutter analysis but this is understandable on considering the extreme Sutter idealisation which assumes that the short, deep sections act as beams over their entire length. In the case of pillars this can be twice their true free length. The material included in such beams is under the control of the analyst who must decide the proportion of the underframe to be included in the lower beam of the truss, and make other critical decisions. The Sutter method is essentially one to cater for the vertical loading case, which in practice is of secondary consideration, with regard to limiting stress levels.

An underframe analysis may be carried out by the same methods for the buffing case, but here allowance must be made for the contribution of the sides, etc. All this approximation and estimation is not required in the matrix-force method, which remains expedient while maintaining a truly integral analysis.

The use of matrix algebra in conjunction with a digital computer to perform the mathematics of the analysis leads to the tabulation of basic data in a concise, systematic and easily checked form, once the coach is idealised. In practice, it is not always possible to achieve the integration apparent in this coach which must lead to less

Continued at foot of next page

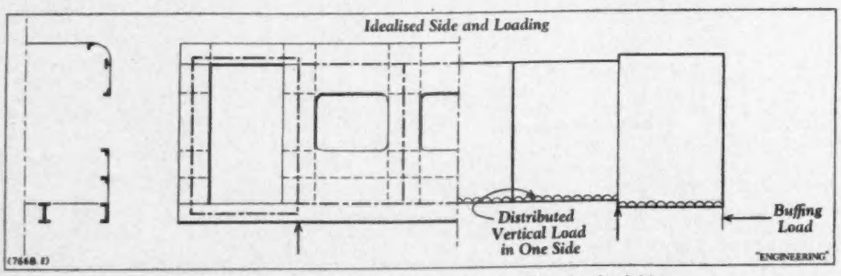
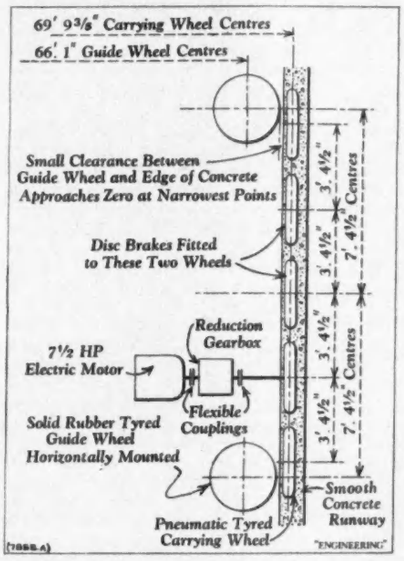


Fig. 5 Sutter analysis of stress case 2a: Buffing load of 25 tons.

Overhead Travelling Crane with Pneumatic Tyres

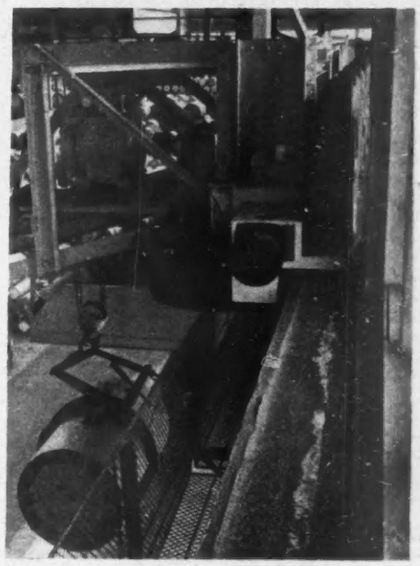
As reported under New Plant and Equipment (ENGNG., 6 May '60, p. 609), an interesting development has recently taken place at the Aylesford (Kent) Mills of the Reed Paper Group, by the fitting of rubber-tyred wheels to a pair of 3 ton overhead cranes. The changeover from conventional steel-flanged wheels running on rails was made to overcome the troubles arising from "cross-binding" that are frequently encountered with cranes of this type, and which, in this particular case, were accentuated by intensive three-shift operation, where long travel and high speed are demanded.

The idea was developed by the consulting engineers, W. S. Atkins and Partners, 158 Victoria Street, London, SW1, in collaboration with Strachan and Henshaw Limited, St. Philips, Bristol 2, who made the new end carriages for the cranes and carried out the work of conversion. In the six months since this was done no significant operating troubles have been experienced.


69' 9 3/8" Carrying Wheel Centres
66' 1" Guide Wheel Centres
Small Clearance Between Guide Wheel and Edge of Concrete Approaches Zero at Narrowest Points
Disc Brakes Fitted to These Two Wheels
7½ HP Electric Motor
Reduction Gearbox
Flexible Couplings
Solid Rubber Tyred Guide Wheel Horizontally Mounted
Pneumatic Tyred Carrying Wheel
Smooth Concrete Runway
3' 4½" Centres
7' 4½" Centres
"ENGINEERING"

(*Left*) *Diagrammatic plan showing arrangement of carrying and guide wheels for one end carriage.*

(*Right*) *End carriage under load showing the wheels, concrete runways and drive assembly.*



The cranes now run on two smooth concrete runways, about 12 in wide, that take the place of the former rail track. Each end carriage is supported and guided by the arrangement of wheels shown in the diagrammatic plan. The five carrying wheels are fitted with standard commercial vehicle type pneumatic tyres (Michelin 7·00-20 "X" Zigzag) inflated to 110 lb per sq. in, having a nominal loaded diameter of approximately 33 in. These tyres are of the radial-cord stabilised-tread type, in which three layers of steel cord are interwoven beneath the tread to provide stiffness at the tread.

The two guide wheels were supplied by the André Rubber Company Limited, and have solid rubber tyres with a nominal diameter of approximately 31 in. They are intended to bear on the sides of the concrete runways in order to keep the crane travelling in a straight path, but since there is a variation of about 2 in between the edges over the whole length of travel, the guide wheels are actually set almost to make contact at the narrowest points.

All wheels have roller bearings, and the traversing drive is taken from two 7½ h.p. Crompton Parkinson electric motors, to one carrying wheel on each end carriage through a Crofts reduction gearbox. The motors are synchronised electrically and together can propel the crane at a traverse speed of 360 ft per minute with a possible maximum of 400 ft per minute. In an emergency it is possible to run the crane on one motor alone at a reduced speed, and this arrangement dispenses with the need for a long common driving shaft.

Braking is provided by Dunlop disc brakes (supplied by Twiflex Couplings Limited) on four wheels, two on each end carriage. Acceleration from rest to full speed can be accomplished in 6 seconds and the braking distance at full speed is 6 ft. As can be seen from the photograph, the arrangement is extremely compact, and the silence and smoothness of operation are remarkable.

Maintenance provision includes access platforms for servicing the drive arrangements and for inflating the tyres when required. Gauges are mounted on each wheel to simplify routine checking of tyre pressures, and screw jacks are built into each end carriage to facilitate wheel changing. A small degree of horizontal adjustment of the guide wheels is also available.

The nominal span and design load capacity of each crane remain unchanged at 69 ft 6 in and 3 tons, respectively. The principal alteration which had to be made to the original crane structure consisted of slightly shortening the centre panel to allow room for the new end carriages. The virtual elimination of the impact factors associated with conventional steel-wheeled overhead cranes, means that in a new installation lighter crane and supporting structures can be envisaged, with a resulting saving in first cost.

Before conversion of the Aylesford cranes, a pair of end carriages was tested thoroughly at Strachan and Henshaw's works, using a specially-constructed test vehicle running on two concrete runways. Irregularities such as might be found in an overhead crane track were deliberately exaggerated and incorporated in the test runways. It was found that a fully-loaded end carriage could negotiate without difficulty a sudden vertical step of 1½ in, and a lateral deviation of 4 in could be tolerated with perfect safety.

In each case, these hazards had no effect on the true-running ability of the test vehicle. The tests also demonstrated that the use of the stabilised-tread pneumatic tyres offers the advantage that, whether heavily or lightly loaded, the effective wheel diameter for travelling purposes remains practically constant, otherwise the crane would tend to slew when travelling with a load near one end.

The Aylesford cranes are believed to be the the first of the overhead type to be modified in this way. The designers claim that new rubber-tyred overhead cranes or conversions are feasible up to 30 tons lifting capacity, using standard commercial-vehicle tyres.

Concluding **The Stress Analysis of Railway Coaches**

regular basic data. However, this lack of integration is a far greater embarrassment to the designer than to the analyst employing the matrix-force technique.

In conclusion it must be stressed that the application of the method is carried out here in its simplest form and refinements both to the writing of the basic data and to the computations are possible (Ref. 4).

Acknowledgment.—The author is indebted to Mr. S. Kelsey, B.Sc. (Eng.), of the Aeronautical Department, Imperial College of Science and Technology (University of London), for his advice and encouragement in the preparation of this report. The cooperation of the London Computing Service (English Electric) in ensuring efficient use of DEUCE for the computations has made possible the accompaniment of the theory by results.

REFERENCES

[1] J. H. Argyris, "Energy Theorems and Structural Analysis. Part I": General Theory. *Aircraft Engineering*, October 1954-May 1955.

[2] J. H. Argyris and S. Kelsey, "Structural Analysis by the Matrix Force Method with Application to Aircraft Wings," *Wissenschaftliche Gesellschaft fur Luftfahrt, Jahrbuch* 1956, p. 78.

[3] S. Kelsey. "The Application of the Matrix Force Method to a Typical Wing Structure," Imperial College, Department of Aeronautics, Paper No. 38, 1956.

[4] J. H. Argyris and S. Kelsey. "The Analysis of Fuselages of Arbitrary Cross-section and Taper," *Aircraft Engineering*, March 1959.

[5] K. Sutter. "The Stress Analysis of a Self-supporting Railway Carriage Body," *Economie et Technique des Transports* (Lucerne 1947).

The foregoing is a digest of Report No. 59/99A/RG obtainable from Norris Brothers Ltd., 62 Church Road, Burgess Hill, Sussex.

Ultimate Loads in Rock and Concrete

The strength of concrete or rock in a foundation depends on the support from the surrounding material. The ultimate strength of both rock and concrete seems to be dictated by one or other of two failure mechanisms.

By T. N. W. Akroyd, M.Sc., LL.B., A.M.I.C.E., A.M.I.Struct.E.
Constructional Services Limited

THE design of concrete structures and the strength of rock foundations require a knowledge of the strength of concrete and of rocks. It is usual to determine such strengths by a simple compression test; in this country by tests on concrete cubes, or on rock cylinders. While this approach has the advantage of simplicity, and though much engineering experience has been built on it, it affords little information as to the actual behaviour of concrete in a structure or rock as a foundation.

A study of the behaviour of concrete when subject to triaxial compression forces is necessary before the actual strength, as opposed to the cube compression strength of concrete, can be determined. In such a study the use of concrete cubes usually has to be abandoned and the work concentrated on cylinders. Such work is not new, for as long ago as 1928 Richart, Brandtzaeg and Brown, carried out tests on concrete cylinders and showed that the strength of concrete increased as the confining pressure is increased.[1] If one adopts, as has been done in the study of soils, the Mohr concept of failure and representation of stress, together with Coulomb's equation,

$$s = c + \sigma \tan \phi$$

then it follows immediately that, as long as ϕ is not zero, concrete restrained in a foundation will carry a greater load before failure when confined than when laterally unsupported.

Work carried out on rocks, principally by Griggs in the United States, has shown that the strength of a rock also increases as the lateral confining pressure increases.[2]

The work on rocks has, however, been carried out mostly by geologists and others who are interested in rock movements and in the ductility of a rock which, brittle when tested in a simple compression test, flows plastically when compressed under high confining pressures.

The structural engineer, however, is concerned in the main with brittle failure, that is, with the brittle fracture of concrete or rock. I leave out of this discussion the effects of long-term creep and changes in Young's modulus. In view of the work carried out on rocks and the fact, demonstrated by Bridgman,[3] that most materials become plastic if the confining stress is high enough, it may be of some comfort to know that concrete behaves as a brittle material under a confining pressure of 10,000 lb per sq. in when tested in a short-term test.

By the adoption of the Mohr stress diagram and the Coulomb equation, it follows that some idea of the actual strength of concrete or rock can be determined from a series of triaxial tests in which the confining pressure is increased until of the same order as the unconfined compression strength, as, for example, the results given in Fig. 1. Apart from the strength of the material, the actual failure mechanism during triaxial compression testing is also important; the consideration of such a failure mechanism may assist in interpreting the behaviour of concrete under simple compression loading while at the same time it may indicate any effect which the method of testing may have on the actual test results.

All who have witnessed compression tests on concrete cubes or cylinders will be familiar with the end cones which are often formed. In a cube failure, these end cones overlap so as to produce the typical waisted shape with planes of failure at 60° to 70° to the horizontal. In the failure of cylinders, however, the cones do not intersect, when the height to diameter is about 2, but the angles of the cones are usually the same.

Other forms of failure also occur; a cone may be formed at one end only, the sample may fail by vertical splitting, or by failure on a single inclined plane. Vertical splitting is fairly common in rocks, but not so common in concrete specimens.

When a brittle but elastic material, such as rock or concrete is compressed the vertical compression is accompanied by lateral strain. The end platens of the testing machine restrain this horizontal expansion so that there is a tendency for the cylinder to become barrel shaped. If one visualises the frictional end restraint as a shear force opposing the bursting effect of the horizontal strain, then this end shear combined with the vertical compression would tend to retain the two conical unbroken ends, while the rest of the material is broken up by vertical cracks.

What, however, is not yet resolved, is whether the end cones form first and, being driven into the sample, wedge it apart along vertical planes, or whether the material cracks vertically first due to horizontal tension and the end cones are formed afterwards. It is here that there is the difficulty of determining how rocks or concrete fail. No evidence on this point is forthcoming.

It may be questioned as to what value there exists in determining the exact mode of failure. The value lies in attempting more fully to understand the behaviour of rock or concrete. If it is assumed that rock or concrete under brittle compression fails by horizontal bursting forces generating vertical cracking, then there is no reason why the material should not fail similarly under triaxial compression tests at high confining pressures. With such a mode of failure it is unlikely that Mohr's theory of failure would apply and hence the Mohr's circles of stress would not apply, notwithstanding the results given in Fig. 1. In fact there is evidence that vertical splitting in concrete and rock does occur even at confining pressures as high as 8,000 lb per sq. in and examples are shown in Figs. 2 and 3.

On the other hand, if to account for vertical splitting the end cones are assumed to form first and to be driven into the sample then, with an increase in confining pressure, the end restraint will become of less importance and failure along either single or conjugate shear planes will take place. But the trouble is that failures take place in a haphazard manner. For example, in a series of triaxial compression tests on rock and concrete at various confining pressures from zero to 10,000 lb per sq. in just as many failures occurred along shear planes, either single or conjugate, as occurred by vertical splitting, while in addition some samples failed by complete collapse of one end of the sample (see Figs. 1 and 2).

On the other hand, Professor Jaeger has reported that in a series of triaxial tests on rocks and also a cement mortar, the failure took place along a single inclined plane.[4] This mode of failure continued even down to such a low confining pressure as 50 lb per sq. in, and since there was no discontinuity in his results between triaxial and unconfined compression tests, it is difficult to postulate that there is any difference in the mechanism of failure between confined and unconfined compression tests.

While the difficulties of determining the mechanism of failure of rock and concrete in compression is further accentuated by the difficulty of separating the effect test procedure on the actual results it appears that broadly speaking there are two schools of thought on failures in compression:

(*a*) Those who favour a theory based on cohesion and internal friction (c, ϕ theory) and

Continued at foot of next page

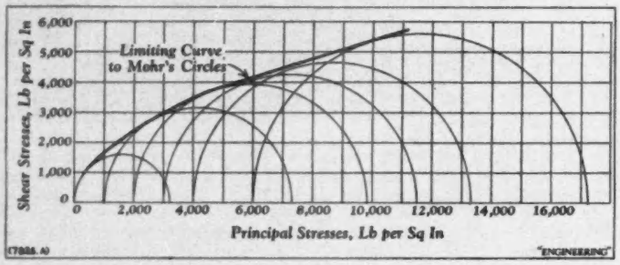


Fig. 1 Triaxial tests on concrete. Mix, 1 : 2·64 : 5·35 by weight. Aggregate, ¾ in gravel; ordinary Portland cement; water/cement ratio, 0·647. Age at test, 4 months.

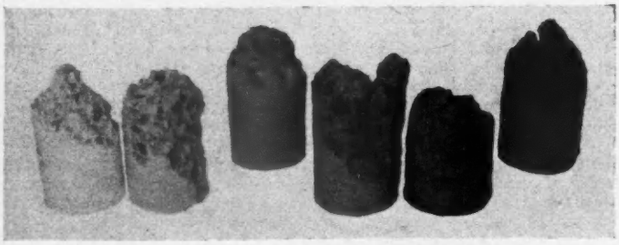


Fig. 2 Concrete cylinders, 6 in by 3 in diameter; failure under triaxial loading. Cell pressures for specimens (left to right): zero, 2,000, 3,000, 6,000, 7,000 and 8,000 lb per sq. in.

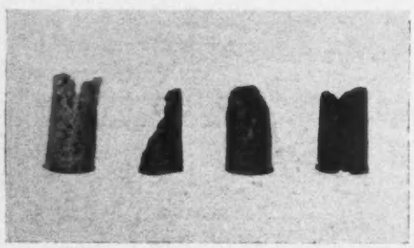


Fig. 3 Granite cylinders, 3 in by 1½ in diameter; failure under triaxial loading. Cell pressures (from left to right): zero, 2,000, 4,000 and 8,000 lb per sq. in.

Underwater Concreting at Oil Terminal Jetty

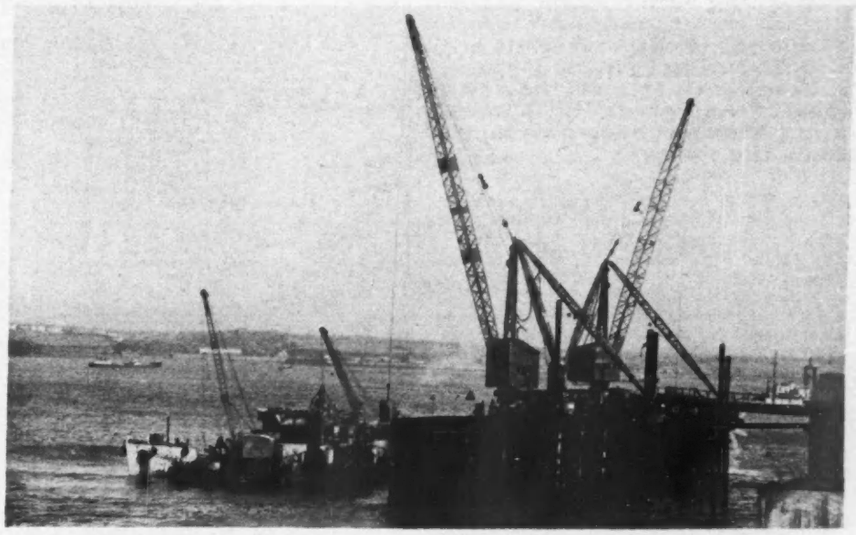
British Petroleum's Angle Bay project in Pembrokeshire on the south side of Milford Haven will be the second of the company's deep water terminals capable of accommodating tankers of over 40,000 tons—the first terminal being at Finnart in Scotland.

The Angle Bay project comprises a jetty of precast post-tensioned concrete construction with mass concrete berthing head dolphins, marine terminal facilities, bunkering tanks, a balancing tank farm and a 60 mile pipeline of 18 in diameter (annual capacity of 5 million tons) to transport the crude oil to the refinery at Llandarcy. The construction has involved handling 15 ton precast beam units for the jetty and the 12 ton fender units. Other problems have been raised by the degree of accuracy with which piling has had to be placed and the provision for pouring large volumes of concrete in the construction of the berthing head dolphins, the work being constantly subject to variations in weather conditions ranging from calm to full gale.

The main feature of the jetty is the two pairs of mass concrete berthing head dolphins, which will have to take the forces arising during the berthing of the tankers; together they will enable two tankers of up to 100,000 tons to discharge at the same time. A hose handling platform is located between the two dolphins of each berthing island. Each dolphin requires 8,000 cu. yard of concrete and the depth of the foundations is as much as 65 ft below low water. The minimum depth provided at the two berths is 54 ft below low water.

The cofferdams for the berthing head dolphins are lozenge shaped and are of Larssen 4B steel piling, the interior excavated by grabbing and finally cleaned out by diver. The concrete is poured in lifts of 6 to 8 ft, divers scraping off laitance between lifts.

The pontoon mounted batching plant which the contractors, Christiani and Nielsen Limited, have designed to supply the mass concrete for the berthing head cofferdams, rests on a pontoon of 104 ft length, 29 ft beam and 4 ft draught. There are two NCK 304 cranes and Blaw Knox equipment comprising two 30 cu. yd 30/4 "Batchmaster" weighbatchers feeding two Rex 28S concrete mixers of 28 cu. ft wet capacity. They discharge through wet hoppers and retractable chutes to tremie buckets of 4 cu. yd capacity for underwater placing by derricks mounted on the piles of the hose handling platform.



Concreting in progress on the berthing heads at the BP oil terminal jetty in Milford Haven using a pontoon-mounted batch-mixing plant.

The storage capacity of the aggregate bins is 30 cu. yd each, the discharge being through radial gates. The aggregates are weighed in a 60 cu. ft capacity bottom discharge weigh hopper, and bagged cement is used. A radial gate controlling discharge from the hopper is opened and closed automatically by the mixer skip, riding in the guides between the batcher and the mixer.

Cement is received in bags on board the pontoon, and sufficient deck space exists between the cranes and the batching plant to store 100 tons of cement, protected from the weather by tarpaulins. The mix for the berthing head dolphins is 1 : 2½ : 5, allowing 25 per cent extra cement for underwater placing, so that the *in situ* mix is about 1 : 2 : 4, intended to give a 28 day strength of 3,000 lb per sq. in. The mix used in the casting yard for the precast units of the shore and trunk arms is 1 : 1½ : 3 giving a minimum strength at 28 days of 5,500 lb.

Recessed fendering has been designed for the berthing heads consisting of four suspended weights at each strong point, the weights being steel boxes filled with concrete. These have a weight of 100 tons and are carried on swinging links. They are arranged to project beyond the face of the berthing head, and will absorb much of the energy transmitted to the head by a tanker when berthing.

Work started on the project in mid-1958, the consulting engineers for British Petroleum being Rendel, Palmer and Tritton, of Victoria Street, London, SW1, and the contractors Christiani and Nielsen Limited, Tufton Street, London, SW1.

Casting a 275 kV line over a 1,000 ft Valley

While constructing the last stage of the Harker-Penwortham 275 kV overhead line for the Central Electricity Generating Board, AEI Construction Division used a coastguard's rocket to make the first crossing of the valley of the River Lune in Lancashire. Despite a high wind they managed to cast a light line, using the rocket, 1,000 ft over the river, a main line railway track, the buildings of a paper mill and an existing low tension power line, all of which were protected by scaffolding.

The line was then used to haul over a steel pilot line and this, in turn, was fastened to a steel yoke to which six steel-cored aluminium conductors (0·4 sq. in copper equivalent) and one SCA earthwire were attached. A second haul pulled over the six line conductors of the other circuits.

This was the second time on which rockets had been used on this contract. Previously a wooded valley had been crossed by this means to save tree cutting. Consulting engineers for the work are Kennedy and Donkin, 12 Caxton Street, London, SW1.

Concluding **Ultimate Loads in Rock and Concrete**

explain that rock or concrete fails along inclined planes of shear. They account for the vertical splitting in compression tests by assuming the material is wedged apart by the end cones.

(*b*) Those who favour a theory based on lateral tension (tension theory) whereby the material fails in compression when the maximum tensile strength in a lateral direction is reached.

The *c*, ϕ theory has some difficulty in accounting for splitting and, if based on Mohr's theory, must ignore that generally it is more suitable for ductile materials; alternatively, the tension theory is forced to explain inclined shear failures as originating from voids in the material or from eccentricity loading, neither of which explanations carry much conviction.

Knowledge of the underlying causes of the failure of rocks and concrete has thus not advanced very much in the last 45 years, for in the analysis of Karman's and Boker's work on rocks,[5] [6] Richart, Brandtzaeg and Brown, in their work on concrete, pointed out just the facts mentioned above; in fact they said:

(1) "that the failure of a material may be controlled by dual law, a tensile or splitting failure occurring with certain stress combinations and a shearing or sliding failure occurring with other combinations."

(2) "that, contrary to the implications of Mohr's law, failure was not entirely independent of the magnitude of the intermediate principal stress."

REFERENCES

[1] Richart, F. E., Brantzaeg, A., and Brown, R. L. *A Study of the Failure of Concrete under Combined Compressive Stress*. Univ. Ill. Eng. Exp. Sta. Bulletin No. 185, 1928.

[2] Griggs, D. T. "Deformation of Rocks under High Confining Pressure." *Jour. Geology*, vol. 44, p. 541, 1936.

[3] Bridgman, P. W. *Studies in Large Plastic Flow and Fracture*. McGraw Hill, 1952.

[4] Jaeger, J. C. "Rock Failures at Low Confining Pressures." ENGNG., vol. 189, p. 283, 26 Feb. 1960.

[5] Karman, T. *Forschungscheft* 118 and *Z. Ver. dent. Ing.*, 1911.

[6] Boker, R. Dissertation, Technische Hochschule, Aachen, 1914.

Taking Steps to Measure Floor Noises

In keeping with current sociological trends, manufacturers of floor covering materials are endeavouring to measure, and subsequently reduce, the noise level of their products. A novel apparatus has been developed to do the former.

By Ernest G. Marklew
R. H. Harry Stanger Laboratories

THERE is little doubt that recent test results on the acoustic values of linoleum have come as a severe shock to certain manufacturers. The results force one main inescapable conclusion, and that is, that as much attention will have to be paid in the future to sound absorbing qualities of linoleum as has been paid to durability and artistic design of that material in the past. It has reluctantly been admitted that sound absorption has not had the priority in Britain that it has had on the Continent.

However, this article is no tale of woe, for there is evidence of increasing attention being paid to the elimination of unwanted sounds generally—and in particular, those caused by impact, where linoleum can play an important part within the sphere of its application. Manufacturers have taken up the challenge in no half-hearted manner, with a display of ingenuity deserving admiration.

The test method herein illustrated and described is designed to provide means to assess the acoustic values of sheet linoleum, or the like, in a manner that will be of practical value to both manufacturer and purchaser.

Taking account of the fact that a prime object of linoleum is to form a surfacing of the floor, it is obvious that the sound to be considered is that caused by impact. There are, of course, many forms of impact: but the form to be considered here is that caused by footsteps. There is no limit to the variety of intensity of sounds caused by footsteps; however, by means of the equipment described below, it is possible to provide a series of standard forces of impact, adequate—not only to produce a figure of acoustic value—but one which is based on a true cause of the sound, rather than an artificial mechanical device introducing frequencies totally unrelated to the true nature of the sound experienced in service. The impacts effected by the impactor described here are practical simulations of footsteps, irrespective of the force of impact.

It is vital to remember that a true assessment can only be obtained when a recovery period is allowed, or, as in the method described hereafter, where no impact is repeated on the same spot on the linoleum test specimen surface. Any repetition of impacts on linoleum, as would be the case with some mechanical devices, would result in compressing the sample and thereby distorting the true acoustic response of the material.

ACOUSTIC MEASUREMENT

Now comes the problem of deciding in what way to state the acoustic value, which shall not only be accurate, but also intelligible to all. The "phon" as we know is the unit of loudness value, indivisibly linked with airborne sound at a known frequency. It must also be remembered that there is, at present, no meter in existence with which to assess the phon value of a sound—either instantaneous or continuous. With sounds caused by impacts we are not dealing with pure tones and so it is better to conduct tests operating on a selection of octave bands, than peak frequencies.

It is here that the sound pressure level meter and the octave band analyser can be used. An omni-directional microphone (Rochelle-salt crystal-diaphragm type) is used with the SPL meter, and it has a substantially level frequency response from 25 c/s to 8,000 c/s. By using an octave band analyser the unwanted frequency bands are eliminated. With the aid of these two pieces of apparatus, operating in conjunction with each other, it is only necessary to choose a common force of impact, arrange a pattern of dispersion of the impacts of that force, then finally set the octave bands at which the analysis shall be made, and one is ready to proceed with both calibration of the test subfloor and testing of the linoleum specimen. The acoustic value in decibels can be assessed for each octave band selected, and from this the mean percentage of sound absorption effected by the test specimen can be stated by comparison with the recordings of the calibration of the test subfloors.

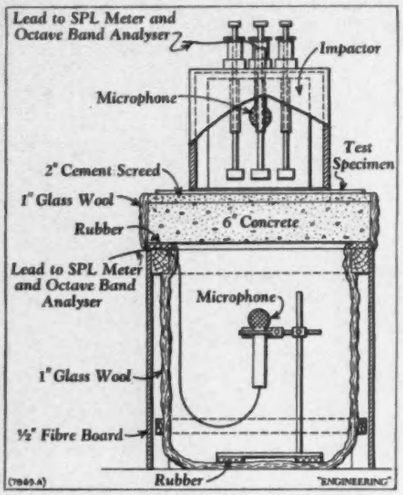


Fig. 1 A four hammer impactor device suitable for the simulation and measurement of the dynamic noise output of floor coverings.

The equipment used to carry out the required tests for any type of floor, is as follows:

(*a*) One sound pressure level meter.
(*b*) One octave band analyser.
(*c*) Standard subfloor assembly 3 ft 0 in × 3 ft 0 in by the thickness depending on the nature of floor involved, mounted on suitable rubber pads and supported by a wooden frame 3 ft 0 in high.
(*d*) A four-hammer impactor device with microphone pick-up.
(*e*) A microphone pick-up placed beneath the test subfloor in the space insulated against the entry of sounds, other than those transmitted through the floor to the "ceiling."

IMPACTOR

The impactor consists of an internally insulated chamber which provides for a clear space within the chamber measuring 12 ft × 12 in. In other words, the base of the walls of the chamber, in plan, would surround this area of linoleum under test.

Four hammers are provided as shown in Fig. 1, and each hammer weighs 500 grammes (exhaustive experiments have since shown, however, that a hammer weight of 250 gm. produces a better simulation of natural conditions). The striking face of each hammer consists of a metal disc 2 in diameter and spherical to a 20 in radius of curvature. The upper position of each of the hammer spindles is suitably grooved at a position on the spindles where they extend through the upper portion of the impactor and at a suitable level so as to be engaged, or held by a trigger, at any desired height above the level of the surface of the floor or test specimen. This is to provide the required force of impact of a free fall under gravity.

For convenience sake a force of 1,000 gm per cm is suggested for all four hammers in all ten of the positions occupied by the impactor during the course of testing. This will provide for a series of 40 impacts and an average of the recordings of these impact responses should provide a very fair overall acoustic value.

Special attention is drawn to the drop hammer mechanism which simulates a footstep—irrespective of the force of impact. Fig. 2 illustrates the mechanism which while permitting the hammer to fall, immediately arrests the return of the hammer, keeping it in the depressed position as would be the case with a footstep. This is of particular importance as it distinguishes this apparatus from all other impact devices. The impacts caused by other devices where the hammers are virtually caught in mid-air on the rebound, are in fact nothing short of drum-beats. Such impacts accentuate the sound and are nothing like what is experienced in service.

Test specimens should be 2 ft 0 in by 2 ft 0 in, and a clear statement as to description and gauge should be given, together with any reference or code number.

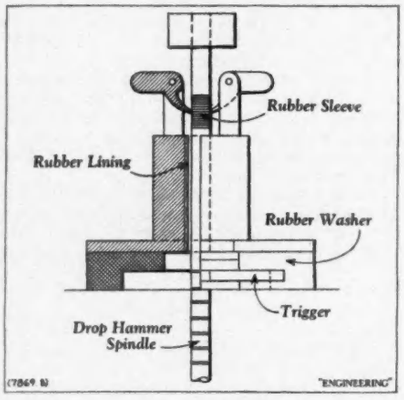


Fig. 2 Footsteps are simulated by a drop hammer mechanism which prevents recoil of the hammer after striking.

It will readily be appreciated that a change in the specification of the adhesive used in connection with these tests could very materially alter the acoustic values. The type or brand of adhesive used in the test must, therefore, be stated. The drying time for the adhesive to set must be stated by the manufacturer. The actual drying time prior to testing must be stated in the test report which may be longer, but never for a shorter period than that specified by the manufacturer.

CALIBRATION

Calibration of the test sub-floor without the test specimen amounts in actual fact to the assessment of the acoustic value of the type of floor in question. Thus, tests on the varying designs of floor construction can be carried out on an experimental and economical basis. In all test certificates it is obligatory for the testing laboratory to state fully the nature of the floor on which the test was carried out.

Fig. 1 illustrates the manner in which the equipment is set up on a test floor assembly. The impactor is set on position 1 (see plan of impactor test position, Fig. 3). Its microphone is in electrical circuit with a sound pressure level

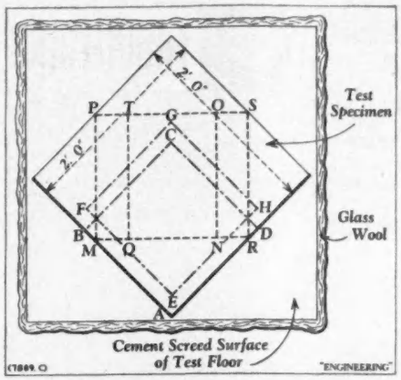


Fig. 3 (left) Pattern of the impactor tests on the specimen.

Position 1 A B C D
" 2 E F G H
" 3
" 4 } A repetition of
" 5 } positions 1 and 2
" 6 } at each corner of
" 7 } test specimen
" 8
" 9 M N O P
" 10 Q R S T

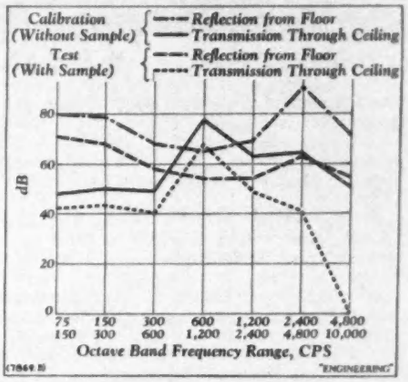


Fig. 4 (right) Typical output graph for 3·2 mm hessian-backed linoleum.

meter which, in turn, is in circuit with the octave band analyser. All four hammers are raised to the 1,000 gm per cm mark, the octave band analyser is set to the required octave band, and, as each hammer is released by pressing the appropriate trigger, a record is made of the sound pressure level indicated in decibels by the octave band analyser. This is done for ten impactor positions and a mean calibration figure is calculated for the octave band in question.

In like manner a calibration is carried out for the other octave bands chosen. It is not a difficult task to work all seven octave bands, as follows:—

75	.. ..	150 c/s
150	.. ..	300 ,,
300	.. ..	600 ,,
600	.. ..	1,200 ,,
1,200	.. ..	2,400 ,,
2,400	.. ..	4,800 ,,
4,800	.. ..	10,000 ,,

The next stage is to assess the response of the impacts at the above mentioned octave bands as would be received through the ceiling. This is done by carrying out the same procedure, except that in this case the microphone which is in the space below the test sub-floor is coupled into circuit with both the s.p.l. meter and the octave band analyser, the impactor microphone being disconnected.

The impacts are repeated and the responses recorded, after which a mean calibration for the "ceiling" is calculated. When the calibration for both floor and ceiling have been obtained for the octave bands in question, they are plotted on a graph sheet. A typical example of a graph sheet is given in Fig. 4.

LINOLEUM TEST

Having obtained the calibration of the test sub-floor, the test specimen is laid on to the surface of the middle of the floor with its sides at 45° to the sides of the sub-floor. It is fixed with the prescribed adhesive in the manner recommended by the client, which should not involve any special arrangements or application. A minimum of 12 hours drying time should be allowed for the adhesive to set before commencing the test. Care must be taken to see that the adhesive is dry, and no test should commence until it is known that the adhesive has, in fact, dried. Extended periods of drying should be noted in the report on the test. The test procedure is then exactly the same as that carried out for the calibration—for both floor and ceiling.

With recordings now available from both calibration and test, having duly plotted those on the graph sheet, the mean percentages of sound absorption effected by the test specimen is calculated and reported, for both floor and ceiling sound absorption.

A graph sheet giving full details should accompany each test referred to in the certificate of test.

It will be appreciated that the application and subsequent removal of various brands of adhesive would render the surface of whatever type of floor surfaces are involved, practically unworkable after about a half dozen tests. This difficulty has been overcome by applying strips of 2 in wide Sellotape over the whole test area.

This permits easy removal, and preserves the original structure of the surface. Tests have shown that the difference in impact responses with and without the Sellotape are negligible.

Marine Communications on Fifty Channels

A new 50 channel VHF transmitter/receiver for marine use has been developed by the Marconi International Marine Communication Company Limited. Known as Argonaut, it is a combined simplex-duplex frequency modulated VHF radiotelephone equipment, designed to enable ships to communicate on the international calling, intership, port operations, and public correspondence channels, and on private maritime frequencies, in the band 156·0 to 163·4 Mc/s.

The equipment has been approved by the British GPO as complying with all the relevant specifications for ship stations working in the international maritime and private maritime services.

Basically, the Argonaut comprises two separate units, each designed for bulkhead mounting. The control unit measuring only 10¼ × 11¼ × 6½ in, incorporates a handset, a loudspeaker and all the operational controls. This unit is used for either local or extended control, and may be separated from the transmitter/receiver unit by 300 ft of cable.

The transmitter/receiver unit, measuring 36¾ × 20¾ × 7½ in, can be installed in any convenient access being required only for servicing. The standard equipment incorporates 15 close tolerance crystals to permit operation on each of 40 channels. A further 10 channels become available with the addition of one extra crystal and a 4·5 Mc/s converter.

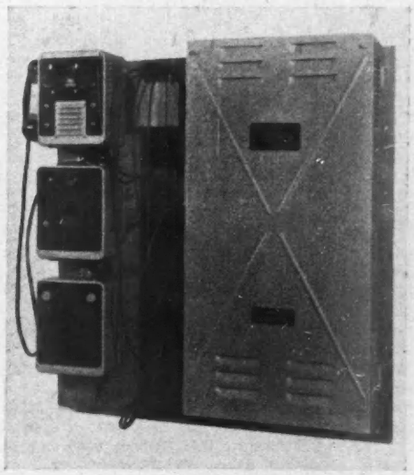
The Argonaut has been designed to operate from 110 or 220 volts d.c. mains; or 115 or 230 volts 50/60 c/s a.c. mains. The appropriate power unit is fitted in the transmitter/receiver cabinet, and receiver watch maintained without the operation of rotary transformers or vibrators. The maximum power rating of the transmitter is 20 watts—the maximum allowed under the Hague agreement. The equipment can also be supplied for direct operation from 220 volt mains with no internal power unit; a transmitter power of 7 watts is then available.

Modulation is FM (frequency modulation), with pre-emphasis and a nominal peak deviation of 15 kc/s at 1,000 c/s in accordance with the technical characteristics contained in the Hague agreement. To prevent distortion due to overmodulation, and to maintain high average modulation for most effective communication, a quick acting volume compressor and clipper limiter has been included in the design of the transmitter circuit.

All controls are concentrated in the control unit. Rapid switching to any of the 50 channels is effected by two decade switches, the selected channel being clearly shown by numerals 0 to 56 appearing in an illuminated window. Lifting the handset applies the transmitter high tension, and pressure on the handset switch brings the carrier on; the equipment being in either simplex or duplex condition depending on the channel in use. A calling/working switch permits direct switching to and from channel 16 (safety and calling) and the preselected working channel. On the channel 16 position an indicator lamp is illuminated and the channel selector window illumination is extinguished.

The transmitter power switch permits a reduction of output power to less than 0·5 watt, a transmission indicator lamp being dimmed in the reduced power condition. A dimmer switch is provided to vary the brilliance of the indicator lamps. The receiving volume control allows a transmission well below full deviation to be turned up to full volume; and in order to ensure that loudspeaker watch is always maintained, the loudspeaker is always on when the handset is on its rest, and always muted when the handset switch is operated.

By the addition of a master local/remote switching unit external to the transmitter/receiver unit, full control (including channel selection) can be switched to one of two control positions. This extension is achieved by electronic switching in the transmitter. A dual watch unit of the same dimensions as the main control unit may be added to the normal control units to provide monitoring for two independently selected channels. Full duplex working on a single aerial is provided by the use of either an aerial relay unit or a duplex filter unit.



The four units of the new Marconi transmitter/receiver are shown in this illustration. In practice the transmitter could be mounted anywhere within 300 ft of the control unit.

Scales Change—Outside

UNDOUBTEDLY experience is the best teacher of cookery. It is also the most expensive. Only experience can replace scales in judging the amount of some ingredient to be added, though those who are experienced can do it with remarkable accuracy. But for the average housewife, the book and the scales are the start of the dish.

Weights are one of the oldest known measurements; stone weights of 7,000 to 8,000 BC are now in the British Museum. The earliest balance in existence is probably the limestone one in the Petrie collection, which dates from the fifth millenium BC, although balances were certainly used earlier than that. Many excellent examples of early scales and weighbridges are in the Avery Historical Museum.

False weights were commented on by Aristotle who was familiar with the steelyard—and the tricks of moving the fulcrum to one side or the other. For this reason its use was banned in this country in 1429. Inspection of weights and measures had been enforced by William the Conqueror, together with the issue of standards, and was reinforced by many later monarchs—with greater or less success. Punishment for the use of "deceitful" weights and measures was the pillory, only abolished (for this offence) in 1816. The principle of the steelyard is still used in most platform scales working in conjunction with a multiplying lever system.

All the earlier scales were the beam type with the pans hung from the balance arm, itself suspended from the hand or from the ceiling. All used loose weights. The weights were, however, subject to loss and corrosion, quite apart from any "adjustments" made by the owner. As a result it was not uncommon for purchasers to take their own scales with them and in Diderot's *Encyclopedia* there is a picture of a balance maker's shop in 18th Century France. Three workmen are depicted and there are a variety of balances hung from the ceiling with pans of different sizes. The guaranteed standard weight with regular inspection has been one of the greatest blessings to the ordinary purchaser.

Balances with weights were in part replaced by the type that uses a pendulum, and these are still to be met with in letter scales and in some installations for really heavy goods. They are also quite common as counter scales where the range can be extended by the addition of weights to the pan. But in the home loose weights have been largely replaced by the spring which cannot be lost and gives very rapid measurement, without handling and to exact subdivisions. Weights are, however, still used for the most accurate measurements as carried out in analytical laboratories, where accuracy to 1 part in half-a-million is perfectly possible and micro balances can weigh amounts as small as one-hundredth of a milligram.

The earliest form of the household spring balance was a small pocket type hung from a hook and with the pan suspended below it. Salter's made such a balance in 1770; it had a helical spring used in compression. The scale was a linear one engraved on a square bar which was attached to the hook and slid out of the body as the weight was increased. Such balances are still to be met quite commonly—fishermen use them for one. A development is the addition of a circular scale with the pointer driven by a rack and pinion mechanism, allowing for more open divisions and so more accurate reading. They are to be met with every day measuring weights up to several tons. The next form was made to stand on the table and is still the type most common in the home.

Early among the pioneers were George Salter who celebrated their bicentenary a few weeks ago. Their pocket balance has already been mentioned and the centre illustration shows one of their models of the mid 1800's. The frame shows the elaboration and decoration beloved of the period, but the principle of operation remains unaltered apart from refinements. This particular machine had two helical compression springs working in conjunction with a rack and pinion to rotate the pointer. The capacity was up to 14 lb with 1 oz divisions.

Three examples of the domestic spring balance. In the centre, one of the earliest models, dating from the mid 1800's. At the right, the Waymaster, showing the change in styling that has taken place, and at the left the Duet which has the unique feature of an enlarged scale for the first 1 lb of weight.

For comparison, on the left is the latest addition to the Salter range. This is the Duet and is unique in having a double scale. The first 1 lb of the scale is opened up to read in ½ oz divisions (a sign of the times? What Victorian family would be concerned with less ½ lb?), while the remainder, up to the maximum of 10 lb, is divided into 1 oz divisions. This arrangement is achieved by having two separate sets of springs: a leaf spring for the first 1 lb and two helical springs for the rest. The leaf spring also acts as a guide for the parallel movement of the load supporting bracket. The linear movement of both types of spring is converted by rack and pinion to the rotary movement of the pointer round the dial. Provision is made for adjusting the zero to allow the use of different containers. The weight of the whole scale is only 2½ lb, very different from the weight of the cast iron Victorian version. The case is a die casting, finished in a choice of colours and the scoop a plastic moulding, marked for the measurement of liquids.

Another example of the modern household scale is the Waymaster shown in the third illustration. It has been accepted by the Council of Industrial Design and carries the Good Housekeeping Institute seal. The scale is made in three sizes with capacities of 5, 10 or 20 lb respectively and in seven colours, emphasising the changing mood of the kitchen in its breakaway from white. An adjusting screw is provided to allow pans of different sizes to be used.

The Duet is made by Geo. Salter and Company Limited, West Bromwich, and the Waymaster by Precision Engineering Company (Reading) Limited, Meadow Road Works, Reading, Berkshire.

ENGINEERING

Published every Friday by Engineering Ltd. at 36 Bedford Street, London, WC2, England.
Telephone: Temple Bar 3663.
Telegrams: Engineering, Lesquare London.

Chairman
J. A. Dixon M.A., A.M.I.Mech.E.

Editor
F. B. Roberts, M.B.E., M.I.Mech.E

Deputy Editors
D. Fisher, Ph.D., B.Sc., A.M.I.C.E., A.M.I.Mech.E.
E. P. Ward, M.A., A.M.I.Mech.E.

Department Editors
Atomic Review
B. G. Bodroghy, D.I.C., B.A.Sc.
Book Reviews
E. P. Ward (Deputy Editor)
Construction
D. Fisher (Deputy Editor)
Design
K. M. Brown
Events in Advance
J. E. Dodsworth
Impact, Human Element, Companies, Marketing
J. D. F. Perry
Metals and Materials
D. C. E. Gribble, B.Sc.
New Plant and Equipment; At Home
A. A. H. Scott, B.Sc., A.M.I.Mech.E.
Operation and Maintenance
W. K. V. Gale
Production
J. R. Trotter, B.A.
Research and Development
R. A. Coffee, D.I.C., A.M.Brit.I.R.E.

EDITORIAL DESIGNER
J. T. Godfrey

MIDLANDS CORRESPONDENT
W. K. V. Gale

SUBSCRIPTION MANAGER
G. A. Roberts

ADVERTISEMENT MANAGER
G. H. Dixon, M.A.

Contributed Articles

Notes for the guidance of contributors are available from the Editor. Contributed articles usually carry the author's name when published; they should be exclusive to ENGINEERING. When an article is accepted for publication the author is normally advised of the planned publication date.

Subscription Rates

One year, inland and abroad £5 10*s* (Canada, £5 5*s*). Three months 27*s* 6*d* all countries. Single copies 2*s* 7*d* post paid.

Back Numbers

Back numbers, from recent issues to certain of the earliest issues from 1866, are available at the usual price for single copies.

Reprints

Reprints of articles which have been published in ENGINEERING can be supplied. Requests for quotations, stating the quantity required, should be addressed to the Reprints Department.

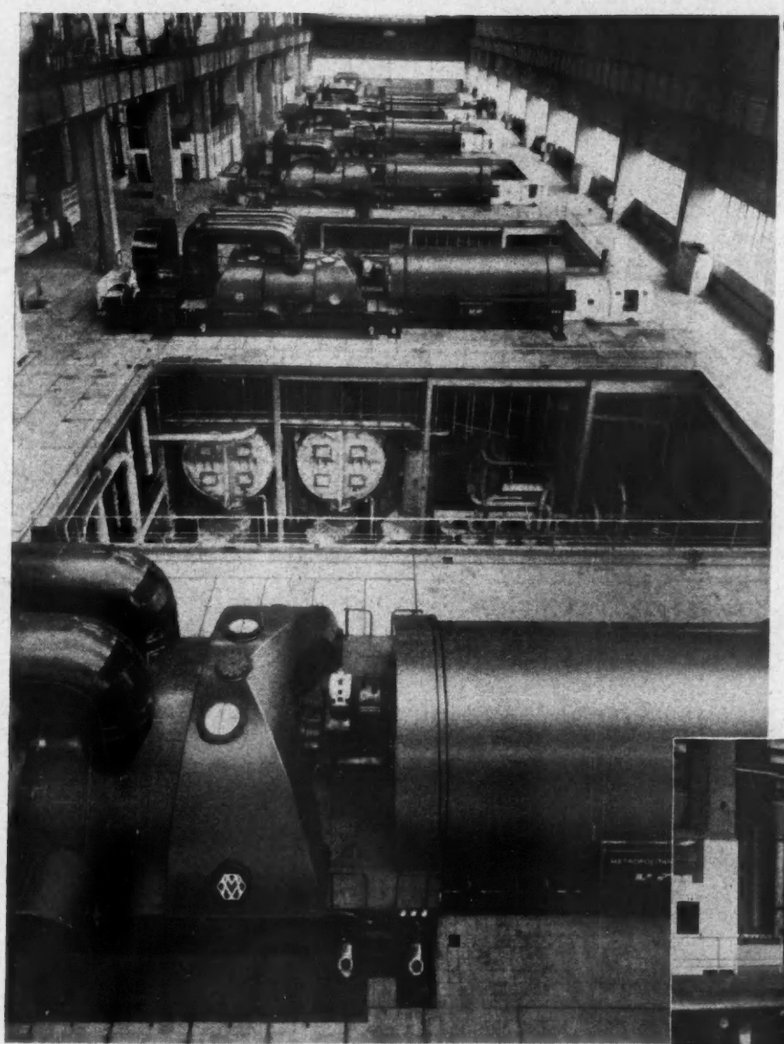
Engineering Information Service

Assistance is available from Engineering Information Service in obtaining information, and in locating sources of information, both technical and commercial. EIS deals, for example, with names of makers and suppliers of plant and equipment, technical data on design, markets for engineering products, and the compilation of references to information on specific topics. Inquiries should be addressed to Engineering Information Service, 36 Bedford Street, London, WC2.

Advertisement Rates

The rates for advertising in the classified advertisement sections (Appointments, Company Meetings, Trade and Technical) are given in those sections The Rate Card, covering all advertisements including display, is available from the Advertisement Manager.

CASTLE DONINGTON



C.E.G.B. East Midlands Division.

The largest single thermal power station in Western Europe

Castle Donington houses six 100 MW 3000 rpm steam turbine-generators together with their associated condensing plants and feedwater heating equipments. All this power plant was manufactured by A E I Turbine-Generator Division.

Castle Donington recorded the highest average overall thermal efficiency of any British power station during the three years ending 31st March 1959.

General view of the complete installation of six 100 MW turbine-generators

The two-cylinder, close-coupled turbines operate with steam conditions at the turbine stop valve of 1500 psig, 1050°F and exhaust to A E I condensers.
Direct-coupled generators produce 3 phase, 50 c/s alternating current at 13·8 kV. The rotor windings are directly cooled by hydrogen circulating in contact with the copper.
The generators are directly connected to the A E I main step up transformers and the power is controlled to the grid by A E I circuit-breakers.

No. 2 set and its twin-shell A.E.I. Condenser.

AEI

Associated Electrical Industries Limited

TURBINE-GENERATOR DIVISION

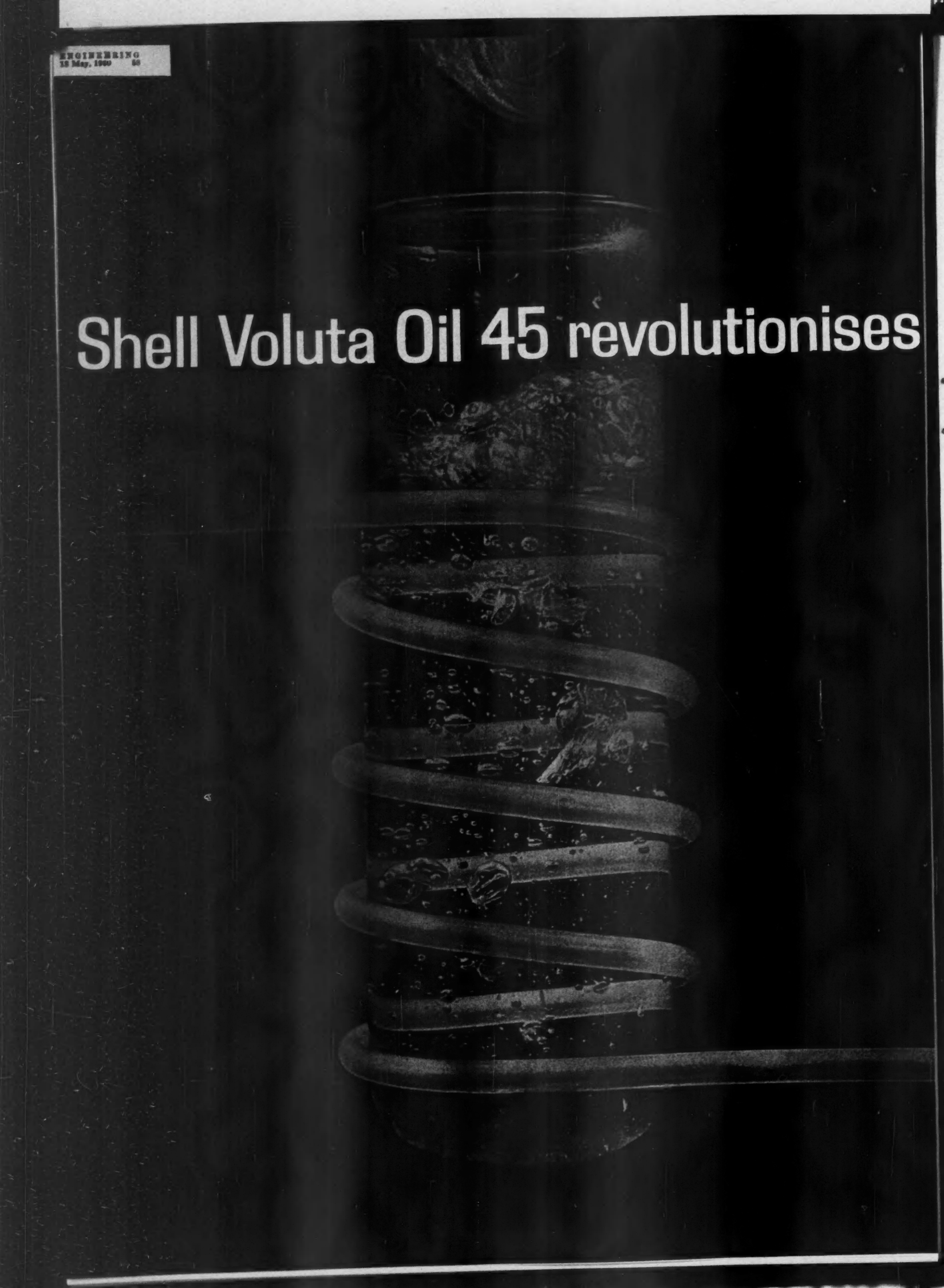
Enquiries to: A.E.I. Turbine-Generator Division; Trafford Park, Manchester 17.

WORKS AT MANCHESTER AND RUGBY, ENGLAND · GLASGOW, SCOTLAND · LARNE, NORTHERN IRELAND

B/A 907

ENGINEERING
13 May, 1960 55

Shell Voluta Oil 45 revolutionises



heat exchange practice

Before Shell produced Voluta Oil 45 it was thought that oils which were to be used for heat exchange purposes must have a high flashpoint—to reduce fire risk—and a high viscosity to prevent excessive leakage through pump glands and to provide adequate lubrication for pump bearings at high temperatures. Heat exchange systems containing these viscous oils, however, were sluggish, particularly when started up from cold. The oil circulated slowly over the source of heat and suffered thermal decomposition, or "cracking". This, in turn, produced low flashpoint materials and carbon which insulated the heating surface.

Shell, therefore, began investigating the suitability of oils of lower viscosity and different chemical constitution. From this research was developed Shell Voluta 45.

Shell Voluta 45 contains hydro-carbons with a saturated ring structure which does not have the tendency that high viscosity straight chain paraffin hydrocarbons had—to break down at high temperatures. Because of its low viscosity Shell Voluta 45 heats up more quickly from cold and circulates more rapidly thus avoiding local overheating and thermal decomposition.

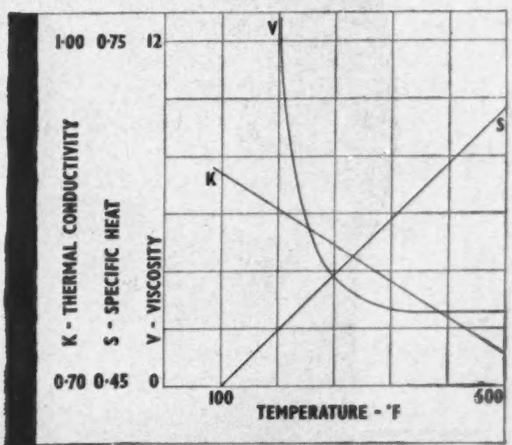
Shell Voluta Oil 45 has excellent heat transfer properties, good thermal stability and good lubricating properties. It is recommended for use in all closed heat transfer systems.

The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Laboratory research to compare the high temperature performance of various oils in a rig simulating practical conditions showed that when oils of varying viscosities were maintained at an average temperature of 325°C. for 200 hours, the closed flashpoint of the high viscosity oils had dropped to a lower figure than that of oils of lower viscosity, indicating that some thermal decomposition had taken place.

Experimental oils were subjected to Heat Stability Tests and to tests designed to measure the variation in heat transfer coefficient with time. The most promising of these oils was then given extensive field trials, both in Shell Installations and in industry. From this extensive research was developed Shell Voluta 45.



Physical properties of Shell Voluta Oil 45.
K. Thermal Conductivity—B.T.U./sq. ft. per hour per 1°F. per inch.
S. Specific Heat—B.T.U. per lb. per 1°F.
V. Viscosity—Kinematic centistokes.

SHELL **HEAT TRANSFER OILS**

another proof of Shell leadership in lubrication

Solve air movement problems with

GYRA-FLO TRADE MARK
AIRFOIL CENTRIFUGAL FANS

The Gyra-Flo Airfoil range of centrifugal fans can be applied to most air movement duties and effects a saving in running costs. Special units are available for high temperature and corrosive fume applications. Consult our Engineers or ask for Leaflet No. Eg.F. 101.

MIDLAND HEATING & VENTILATION Co., Ltd.

BEDFORD ROAD, BIRMINGHAM 11

BIRMINGHAM: VICtoria 3781-5 **LONDON: BECkenham 1503**
GLASGOW: BIShopbriggs 2667 **STOCKPORT: WOOdley 3611**

MAKERS OF **MIDAC** *DUST & FUME CONTROL UNITS &* **AQUAMISER** *COOLING TOWERS*

Brayshaw Furnaces installed at Messrs. Samuel Osborn & Co. Ltd., in their new factory at Holbrook, Sheffield, which is engaged in the production of "SOCAST" Precision Steel Castings.

Brayshaw FURNACES

For Precision Heat Treatment

Once again furnace design by Brayshaw is playing a vital part . . . in a new industrial advance . . . In the development of their "SOCAST" Precision Steel Casting techniques and for the increasing production flow from their new factory Messrs. Samuel Osborn & Co. Ltd., have specified Brayshaw Furnaces. This choice demonstrates a confidence in Brayshaw design and manufacturing ability that is shared in increasing measure by forward looking concerns the world over. Expert consultation on new projects, re-equipment, conversion, repair and general maintenance of all types of plant is immediately available on request please do not hesitate to . . .

Ask BRAYSHAW, the specialists in design and construction of internationally famous furnaces

BRAYSHAW FURNACES LIMITED

BELLE VUE WORKS, MANCHESTER 12

Telephone: East 1046. Grams: Hardening, Manchester.
Sheffield Office: 84 Blonk Street, Sheffiel 3 Tel.: Seeffield 22449
London Office: 232 Bishopsgate, E.C.2. Tel.: BIShorsgate 3575/6

See our exhibit at STAND No. I.A Grand Hall, Ground Floor. International Machine Tool Exhibition OLYMPIA June 25 to July 8th

Industrial Furnaces for all purposes including:

ANNEALING
CARBURISING
GALVANISING
HARDENING
FORGING
MELTING
TEMPERING
TINNING etc.

TALKING ABOUT

WEIGHTY PROBLEMS

or Big Jacking Experiences

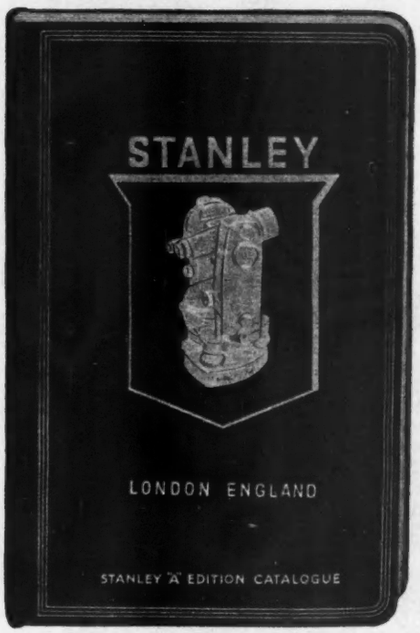
Tangye Jack . . . feels that HE "has had the lot."

From the positioning of Cleopatra's Needle in 1878 to the raising of the Jacques Cartier bridge, the recent outstanding engineering achievement. From the historical launching of the Great Eastern in 1858 to the levelling of the huge caisson for the Hinkley Point power station suction-intake. 'Tangye Jack' thrives on Jacking problems and is still enjoying new experiences almost daily.

TANGYES LIMITED

SMETHWICK BIRMINGHAM PHONE SME 1181

AD No.82



Your guarantee of satisfaction

Always refer to the

STANLEY

"A" EDITION CATALOGUE

The "Stanley" range comprises all that is best in :

Surveying Instruments and Equipment.
Drawing Instruments.
Drawing Office Equipment.
Drafting Machines. Drawing Scales.

Mathematical Instruments :
Planimeters, Integrators, Integraphs.
Harmonic Analysers, etc.

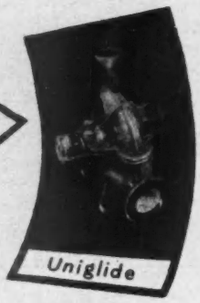
Copies of the "A" Catalogue will be sent on request. (Eng. A1)

W. F. STANLEY & Co., Ltd.

Head Office and Main Works : **NEW ELTHAM, LONDON, S.E.9**
Phone : ELTHAM 3836. *Grams : "Turnstile" Souphone, London.*

Showrooms : *79/80, High Holborn, London, W.C.1.* *(Holborn 2684)*
Branches : *13, Railway Approach, London Bridge, London, S.E.1.* *(Hop 0871/2)*
52, Bothwell Street, Glasgow, C.2. *(Central 7130)*

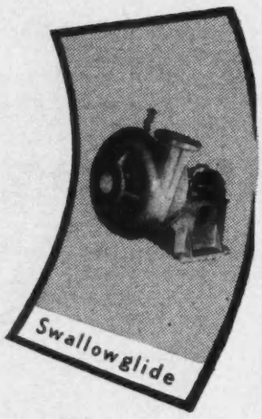
I'll swop you my Swallowglide for your Uniglide



NO! That can't be done. Harland Swallowglide and Harland Uniglide pumpsets are NOT interchangeable—each is built for a specific duty. Uniglides are for handling usually clean water, whilst Swallowglides are for pumping slurries, sludges and solids in suspension.

But you will be glad you changed to Harland pumpsets. You have purchased reliability, efficiency, easy maintenance and a first rate overall engineering service. Swallowglides can be mounted vertically or horizontally. The impeller is designed to be unchokeable. They handle sewage, effluents, waste fibrous materials, offals and pulps, sweepings, syrups, oils and greases, potatoes and peas, and sludges and slurries of all kinds.

Uniglides are single stage pumps designed for maintained maximum efficiency and reliability. All rotating parts are dynamically and statically balanced, ensuring smooth running and long life. The casings are split horizontally with suction and delivery branches formed in the lower half. This feature, and split glands, facilitate maintenance.

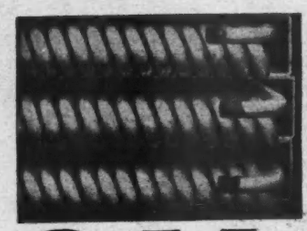


For more specific information ask for these leaflets:—Uniglide – No. 110/1.
Swallowglide No. 180/1.

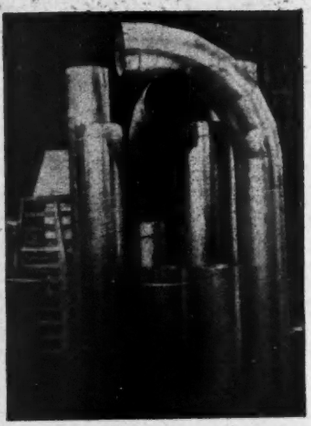
HARLAND pumps

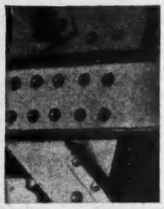
THE HARLAND ENGINEERING CO. LIMITED
ALLOA SCOTLAND **Phone Alloa 390**

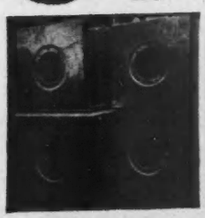
London Office: Harland House 20 Park Street London W1. Phone Grosvenor 1221. Branches: Bristol Glasgow Leeds Timperley (Cheshire) Newcastle-upon-Tyne Nottingham Wolverhampton and overseas.



HOT GALVANIZING FIRST MAKES STEEL LAST







For further information write to
the Hot Dip Galvanizers Association
34 Berkeley Square London W.1

G.P.O use I·C·T computer

TIME OF STORES PROVISIONING CUT BY TWO-THIRDS

Without the efficiency of their stores provisioning, G.P.O. telecommunications could never be the extremely competent public service that they are today. Every one of the 30,000 items stocked should be available immediately throughout the vast country-wide network; yet, to avoid locking up too much capital, no item must be overstocked.

This is one of the world's most formidable stock control jobs. With their advanced thinking it was natural that the G.P.O. should turn to electronics to increase their efficiency. They chose for immediate use an I·C·T 1200 series computer. This computer has been working for a year only, but it has already demonstrated its value as a tool for controlling a stock-holding worth £48 million.

It accurately reviews thirty thousand items each month; indicates unbalance, excesses and shortages, and consistently assists in maintaining the stores holding at the practical minimum. In fact, as Mr. Bevins, the Postmaster General, said recently: 'This computer has allowed us to cut by two-thirds the time taken to obtain the key facts we need to keep our stock of 30,000 different items of engineering stores adequately, but not more than adequately, replenished'.

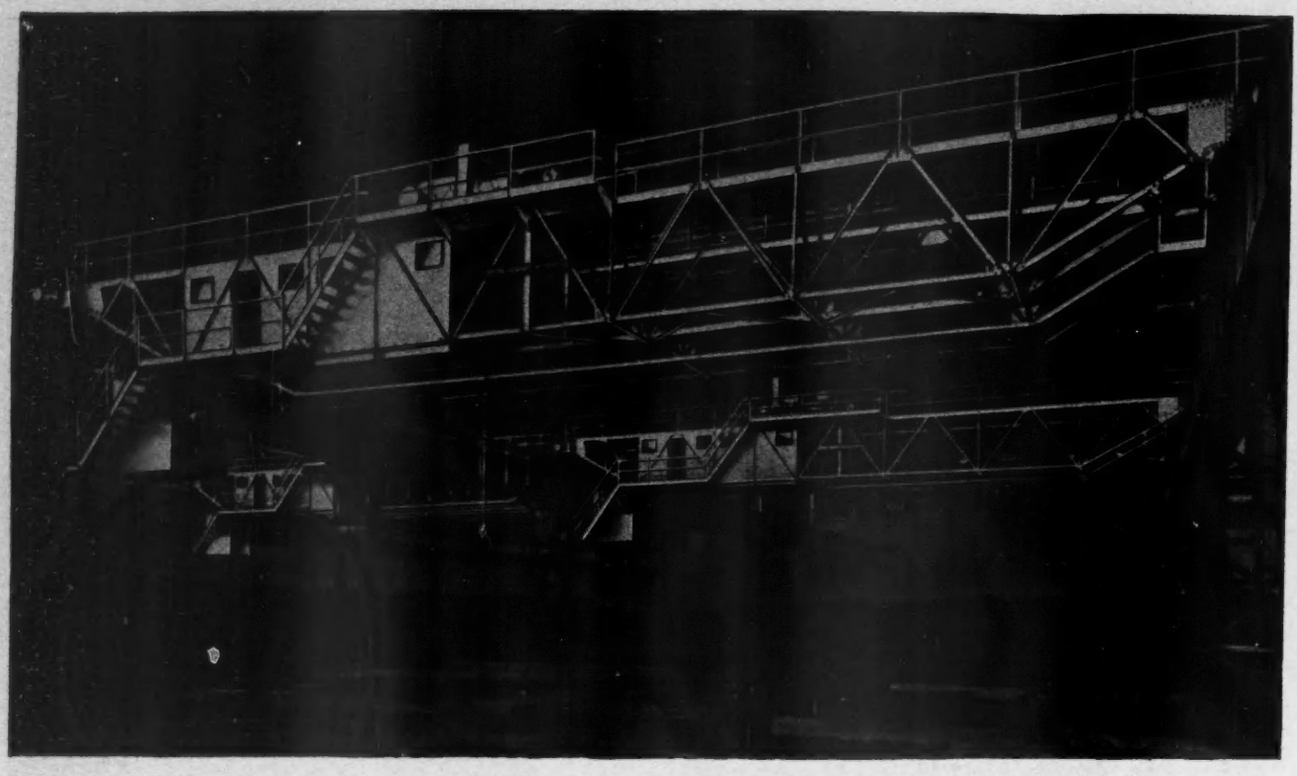
An I·C·T computer can help your business, too

It can make *your* wires hum faster by directly assisting your management and financial accounting, production control, or whatever your particular problem may be. A computer is certainly a major investment; but the dividend it pays is enormous.

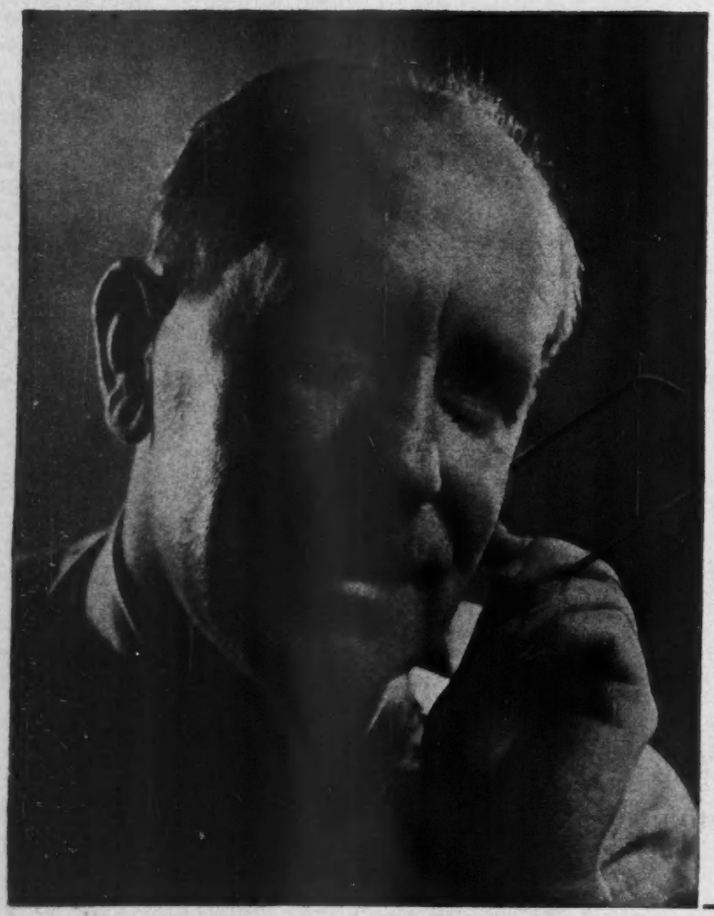
ICT

International Computers and Tabulators Limited

for Britain's most widely used commercial computers
149 Park Lane, London W1



No problems **OVER** his **HEAD**..!



...he can rely on his...

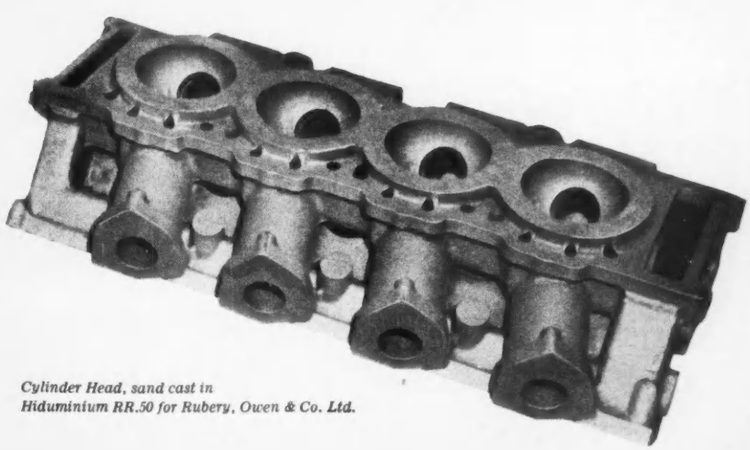
John Smith CRANES

JOHN SMITH (KEIGHLEY) LTD.
P.O. Box 21 • The Crane Works • Keighley • Yorks.
Tel: Keighley 5311 (4 lines) grams: Cranes, Keighley

London Office: Buckingham House, 19/21 Palace Street Westminster, London, S.W.1 Tel: Tate Gallery 0377/8

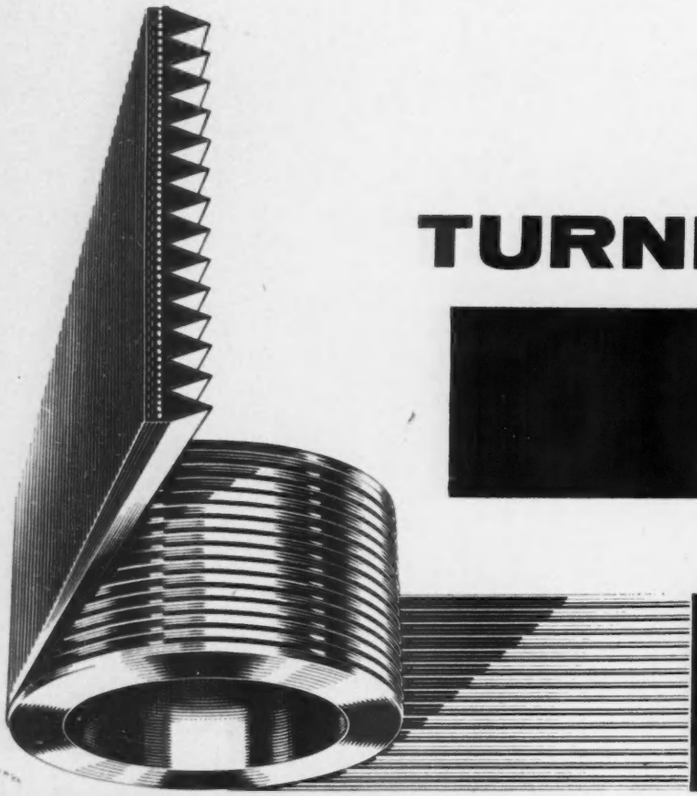
Southern Counties Office: Brettenham House, Lancaster Place, London, W.C.2 Telephone: Temple Bar 1515

it can be done



Cylinder Head, sand cast in
Hiduminium RR.50 for Rubery, Owen & Co. Ltd.

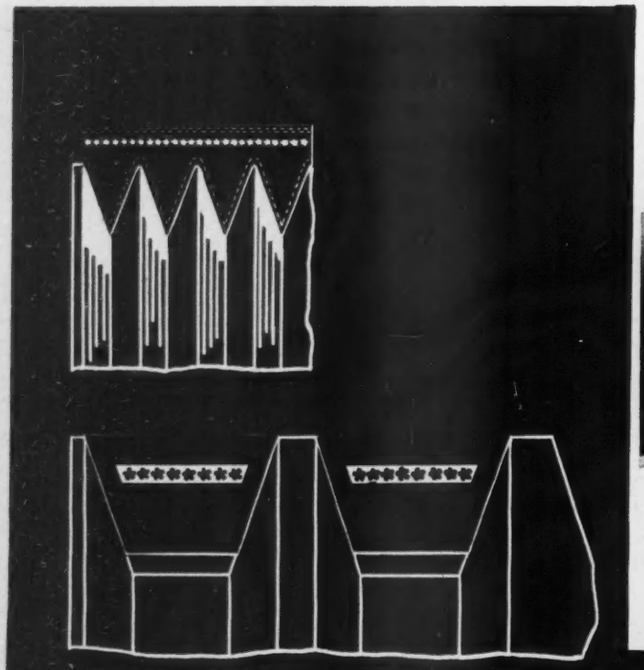
Hiduminium Aluminium



TURNERS DRIVES

Comparative illustrations are ACTUAL SIZE

A NEW concept of



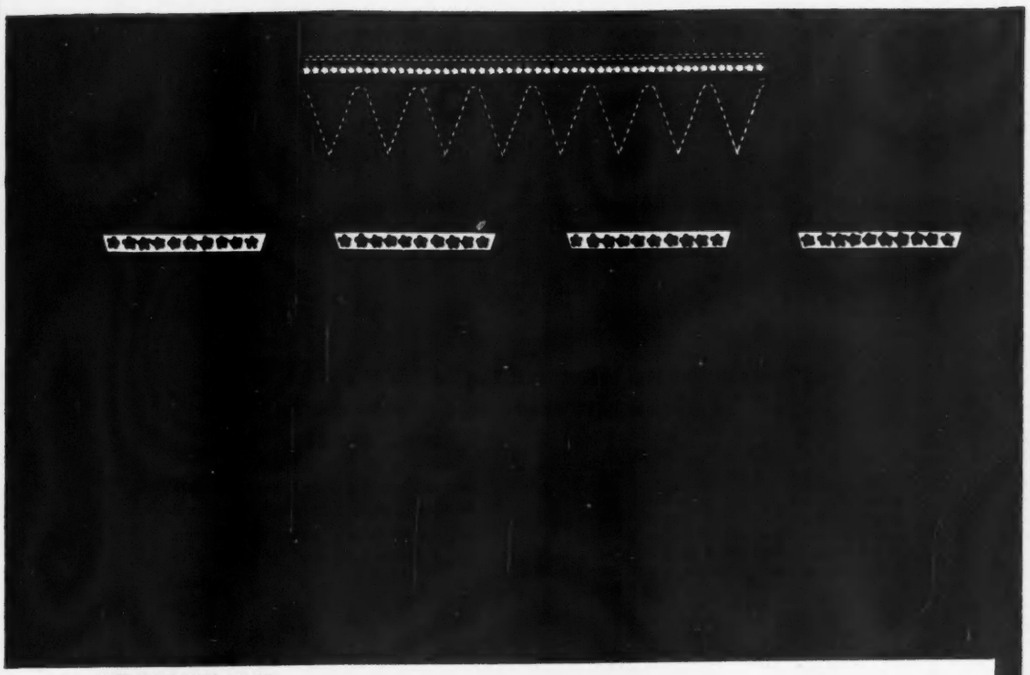
'POLY-V' BELTS ELIMINATE 'MATCHING' PROBLEMS

. . . this means
GREATER DEPENDABILITY
FREEDOM FROM VIBRATION DUE TO BELT SLAP
LONGER DRIVE LIFE
LESS MAINTENANCE TIME

The "Poly-V" Belt is a SINGLE UNIT across the full width of the pulley, not an assembly of several V-Belts which may vary in exact length and ride differently in the pulley grooves.

'POLY-V' DRIVE advantages . . .

1. "Poly-V" Belts transmit the same horse power as conventional V-belts on very much narrower pulleys. 2. The unique design of the "Poly-V" Drive reduces pulley widths to the minimum, resulting in maximum saving in space, pulley weight and costs. 3. In a "Poly-V" Drive installation smaller pulley diameters can be used for the same speed ratios. 4. Being single units, "Poly-V" Belts overcome matching problems associated with other multiple belt drives. 5. Constant pitch diameters at all loads are maintained on "Poly-V" Drives. 6. "Poly-V" Drives ensure minimum vibration and cooler running.



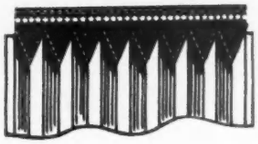
NO OTHER BELT delivers more power in the same space.

HERE is a revolutionary drive which consists of a single endless belt with longitudinal V-ribs and which drives pulleys grooved especially to mate precisely with them. The uniform pull of this single unit belt distributes drive load evenly over the full width of the pulley . . . resulting in a higher horse power capacity per inch of drive width than ever before possible.

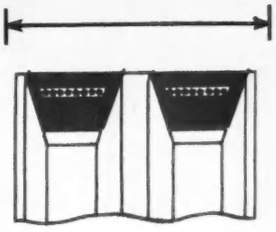
COMBINING the simplicity flexibility and unitary strength of flat belts with the "V-Belt" advantages of high speed ratios, short centre distances and freedom from slip.

FOR FURTHER INFORMATION on "POLY-V" cross sections 'M' ($\frac{3}{8}$" wide) 'L' ($\frac{3}{16}$" wide) and 'J' ($\frac{3}{32}$" wide), sections write for publications BPV 1 and 7.

'POLY-V' BELTS TRANSMIT MORE POWER BECAUSE THEY HAVE DOUBLE THE DRIVING CONTACT AREA

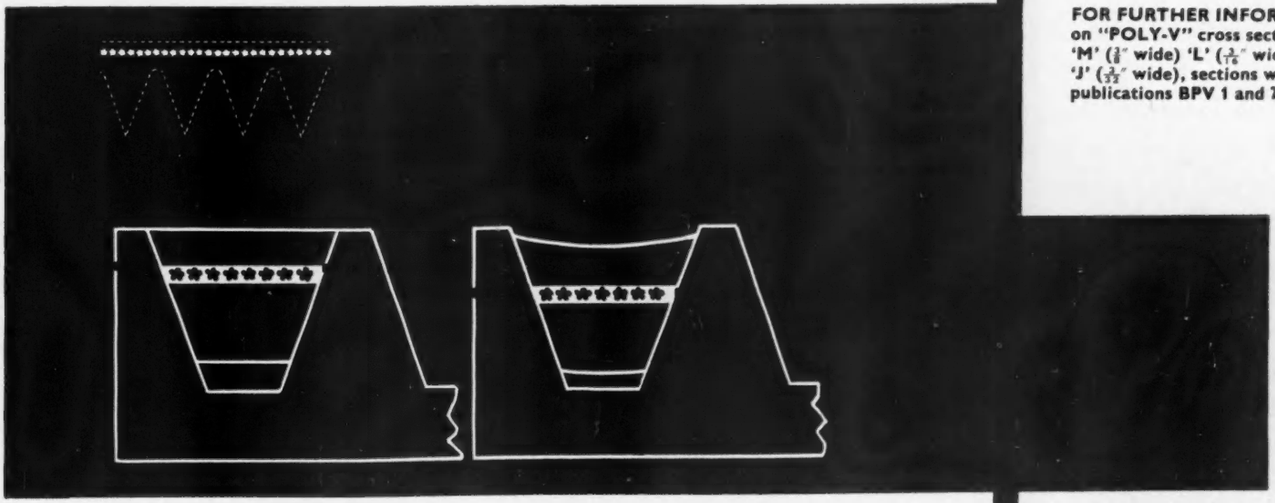


MEASURE THE TWO LINES AND YOU WILL SEE THE GREATER CONTACT AREA OF A "POLY-V" BELT IN THE PULLEY GROOVES



Full contact area over the entire pulley driving surface gives uniform grip. Cooler running arises from the larger belt and pulley driving surfaces.

Reduced pressure per square inch between belts and pulleys leads to less driving face wear, and long service life. Uniform Grip. Cooler Running. Less Wear.



7. "Poly-V" Drives provide greater interchangeability of belts and pulleys because there are only two belt cross sections instead of five for multiple V-belt drives. **8.** Longer lives of belts and pulleys are obtained on "Poly-V" Drives. **9.** "Poly-V" Belts are heat and oil resistant. **10.** "Poly-V" Belts, due to their small rib section, can be used in place of flat belts by cutting grooves in existing pulleys. "Poly-V" conversions on stepped pulleys are particularly successful. **11.** Reverse idlers can be used without serious reduction in belt life. **12.** On quarter turn drives, losses of power are negligible because of elimination of drag and chafing.

TURNER BROTHERS ASBESTOS CO., LTD.
SPOTLAND · ROCHDALE
ENGLAND

Telephone Rochdale 4221 (10 lines).
Telex 63-174.

A MEMBER OF THE **TURNER & NEWALL** ORGANISATION

CW 6789

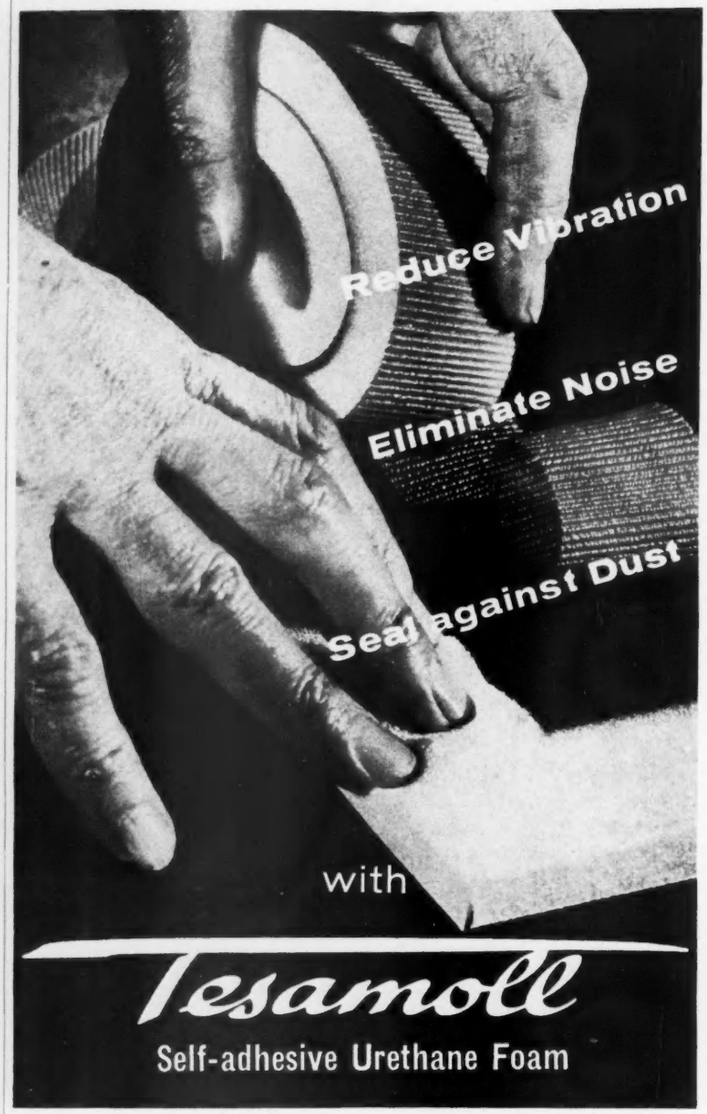
6,720 lbs Pressure for only £135 Cash!

A Bench Press that weighs only 2¾ cwts. and gives you a 3 Ton downstroke Pressure at ⅜" per second pressing time, certainly meets many everyday industrial requirements. The fact that it can be used in series, as shown here, gives it an appeal far in excess of that for which it was originally designed. Any enquiry as to its adaptability for your particular needs will be promptly met, and the all-in ex works price of only £135 makes this an extremely attractive proposition.

PILOT

PILOT WORKS LTD.,
Manchester Road, Bolton.
Tel: Bolton 5545

LONDON OFFICE
3 Southampton Place, W.C.1
Tel: CHA 5130



REDUCE COSTS and SPEED PRODUCTION

Tesamoll is a new synthetic material with unique features, Its interconnected cellular construction compresses easily and has a constant gentle push-back. It is rapidly replacing foam rubber and felt as well as giving results not always possible with traditional materials.

IN ELECTRONICS. Tesamoll has many uses in this modern sphere to mount instruments, cushion, pack, eliminate vibration and seal against dust.

ENGINEERING. Tesamoll can be used as gaskets for powder chambers, to seal against dust, to mount small components, to reduce chatter and vibration and noise.

RADIO AND TELEVISION. Tesamoll is invaluable because of its unique electrical, acoustical and dust sealing qualities. It is ideal for sealing T.V. tubes because it is electro-statically negative and tends to repel dust and other air or gas borne particles.

SAVE TIME. Tesamoll has a powerful pressure-sensitive adhesive which adheres firmly and instantly to any dry, clean surface. Self-adhesive Tesamoll saves many man-hours, is clean and quick to use and efficient in operation.

TESAMOLL can help you too. Tell us your problem, we may well have the answer. Please ask for samples for testing.

Send for technical booklet ▶

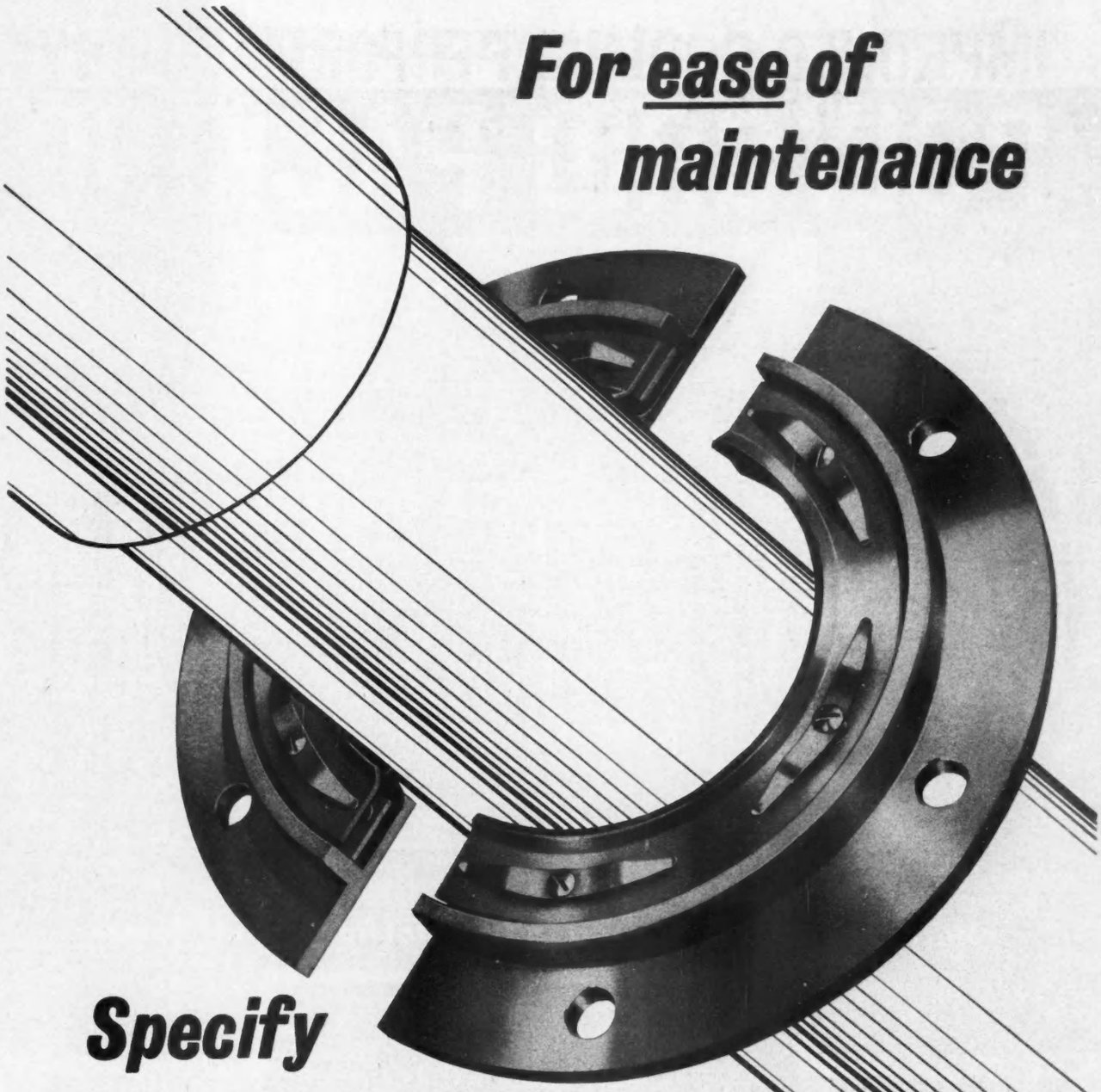
giving full details of the physical, acoustic, electrical and chemical characteristics together with the range of thicknesses, widths and prices obtainable from:

Tesamoll

SEALDRAUGHT LIMITED

CHANDOS HOUSE, BUCKINGHAM GATE, LONDON, S.W.1. Tel: ABBey 3571/2

For ease of maintenance



Specify

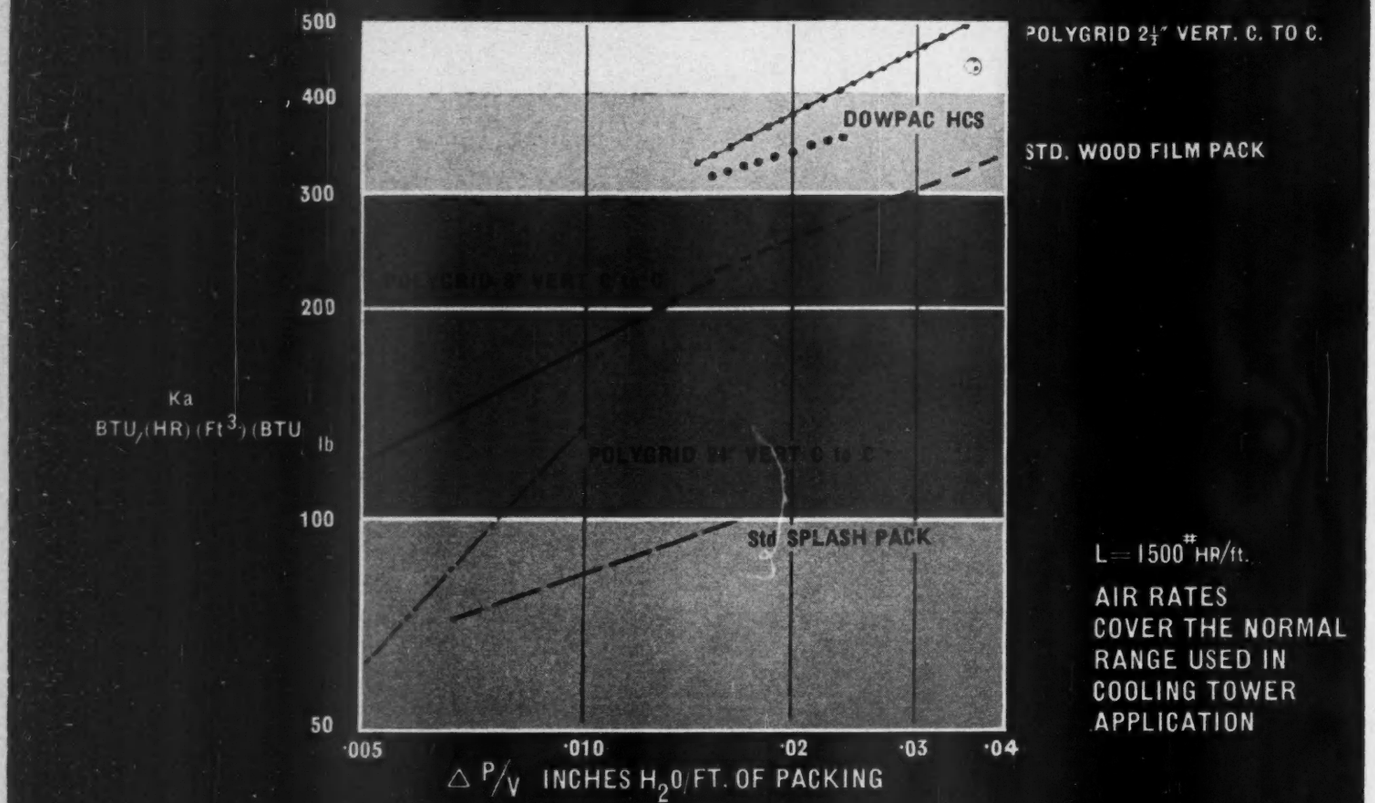
WESTON

SPLIT SEALS

CHARLES WESTON & CO. LTD. Irwell Bank Works · Douglas Green · Pendleton · Salford 6

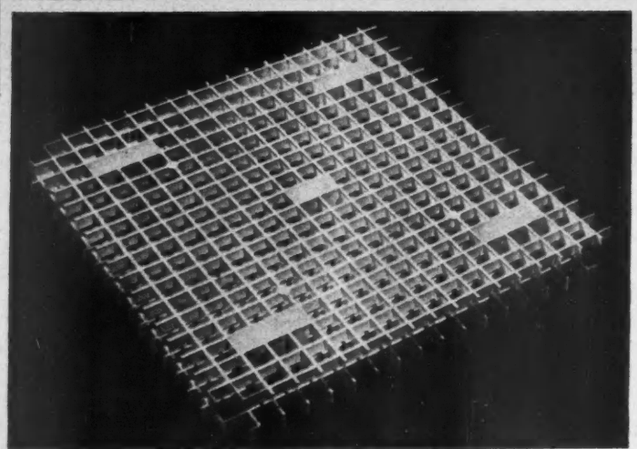
Telephone: Pendleton 2857-8-9; Telex 66-255; Birmingham Erdington 5459; London Holborn 0414; Telex 2-2687

IMPROVED COOLING PERFORMANCE BY
POLYGRID PACKING



Performance of Polygrid in Counterflo Cooling Tower

Polygrid—a new high-efficiency non-corrosive plastic packing has been performance-proved in more than 100 cooling tower installations. It is used exclusively in Head Wrightson Fluor Counterflo towers. Head Wrightson Processes Ltd. will also install it in established mechanical or natural draught towers of all types and makes to increase their efficiency and performance.



Polygrid is a moulded unit of two inch squares. Units, staggered in layers, break hot water into droplets as it cascades through the tower. Available in high impact polystyrene for resistance to water, acids, salts and alkalis, and in high density polyethylene for cooling water contaminated by hydrocarbons.

THE INDUSTRIAL COOLING ENGINEERS

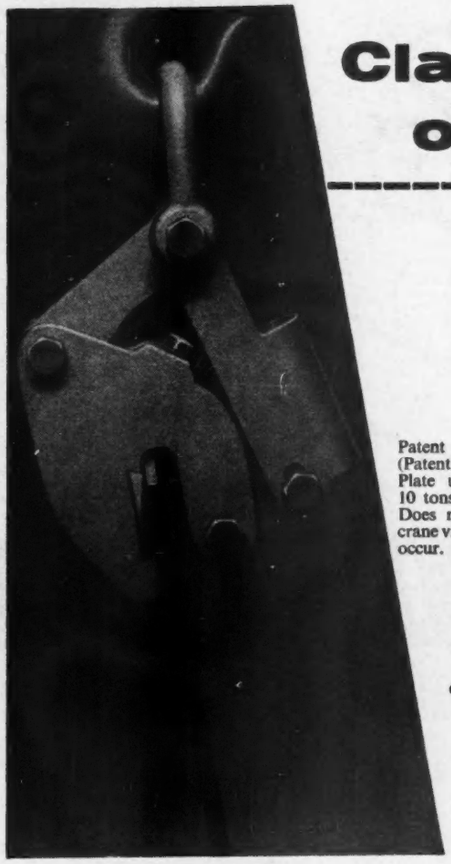
HEAD WRIGHTSON PROCESSES LTD

London and Sales Office: 20/24 OLD STREET LONDON ECI

Head Office: The Friarage · Yarm · Yorks

OFFICES AT: P.O. BOX 1595 SYDNEY · P.O. BOX 1034 JOHANNESBURG · P.O. BOX 2608 CALCUTTA
P.O. BOX 706 HAMBURG *Associates in the U.S.A., Fluor Products Co., Los Angeles, New York, Chicago, Tulsa, etc.*

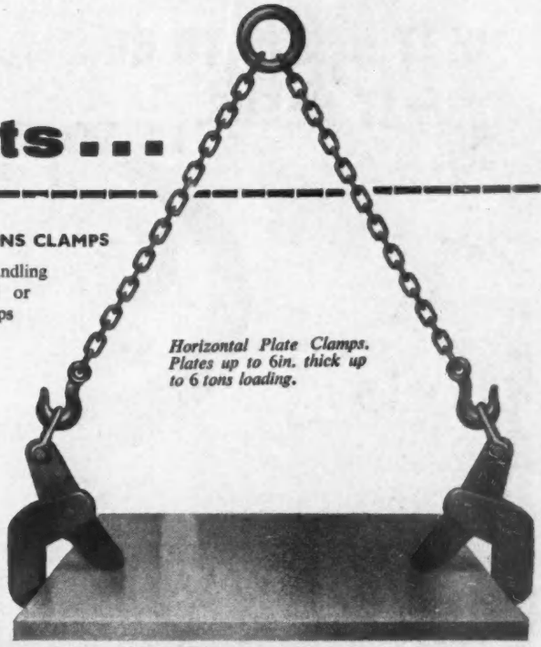
P.5001



Clamp down on accidents...

SAFER PLATE HANDLING WITH GREENS CLAMPS

Whether your problem is handling steel plate in the vertical or horizontal position, our clamps will do it quicker and safer.



Horizontal Plate Clamps. Plates up to 6in. thick up to 6 tons loading.

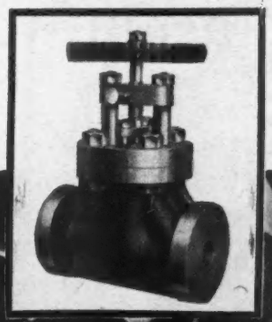
Patent Vertical Plate Clamp (Patent No. 741956).
Plate up to 6in. thick up to 10 tons loading.
Does not drop the plate when crane vibration and load bumping occur.

ENGINEERS
Chain & Forging Manufacturers

RICHARD GREEN LTD

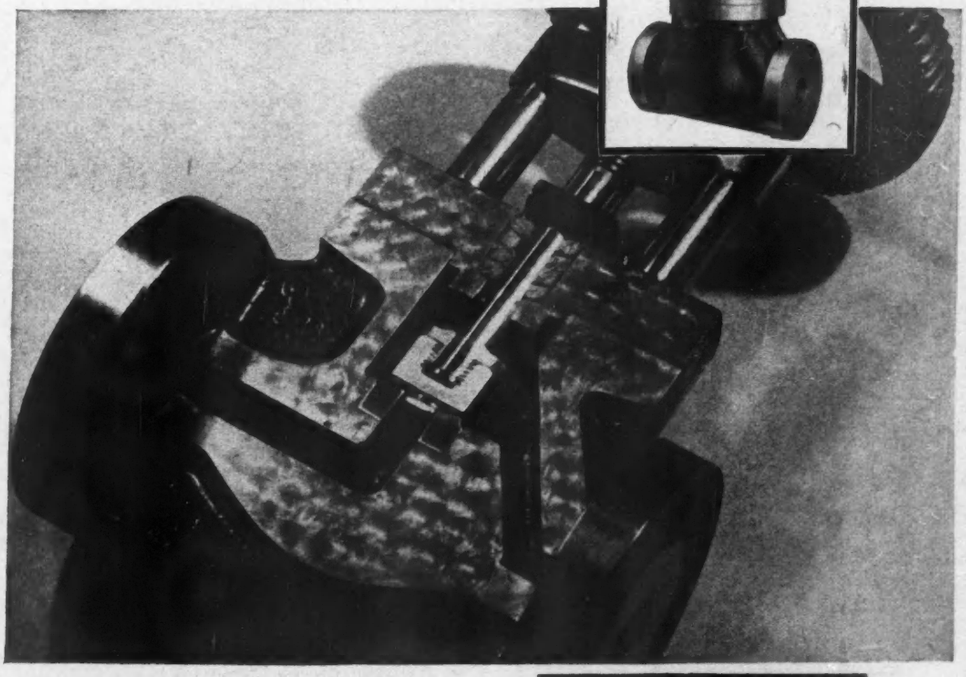
P.O. Box No. 8, Cokeland Works, Cradley Heath, Staffs, England. Telephone: Cradley Heath 66061/2/3

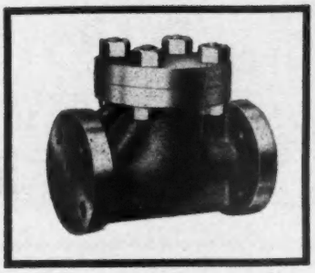
FORGED STEEL VALVES



A sturdy, durable range of globe and angle body stop valves for exacting conditions on small steam lines, drain duty, high pressure water or oil services, etc. The valves are of outside screw type, with stainless steel spindle, solid drop forged steel body, and Superalloy or Stellite face and seat according to conditions. Cone stopper can be fitted for flow regulating duty.

Corresponding check and controllable check valves are available, also forged steel piston-sleeve valves, parallel slide valves, relief valves, and pipeline strainers.

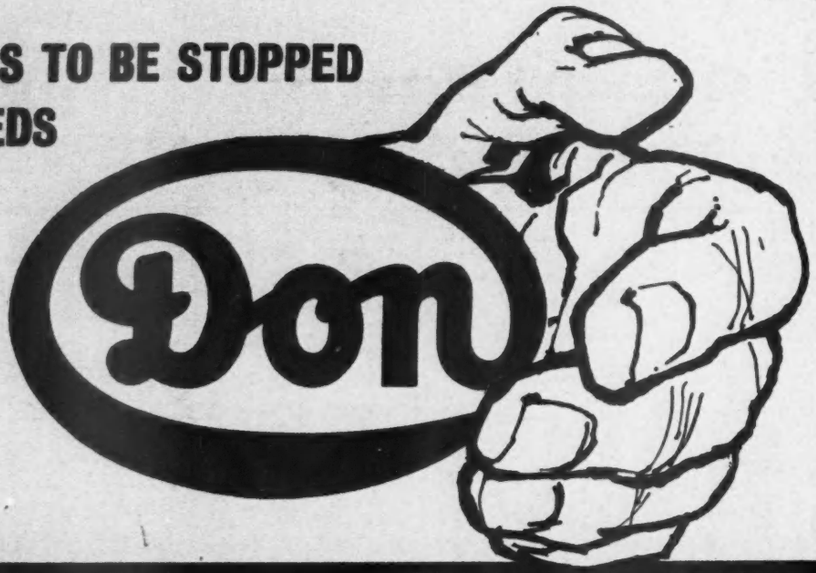




J. BLAKEBOROUGH & SONS LIMITED,
BRIGHOUSE ENGLAND

BLAKEBOROUGH

IF IT NEEDS TO BE STOPPED
—IT NEEDS



FOR RUGGED DUTY!

FOR LONG WORKING LIFE!

FOR EVERY INDUSTRIAL BRAKE AND CLUTCH NEED!

INDUSTRIAL BRAKE LININGS

For Technical Information get in touch with your nearest Don depot

SMALL & PARKES LTD

HENDHAM VALE WORKS · MANCHESTER 9

COLlyhurst 2511

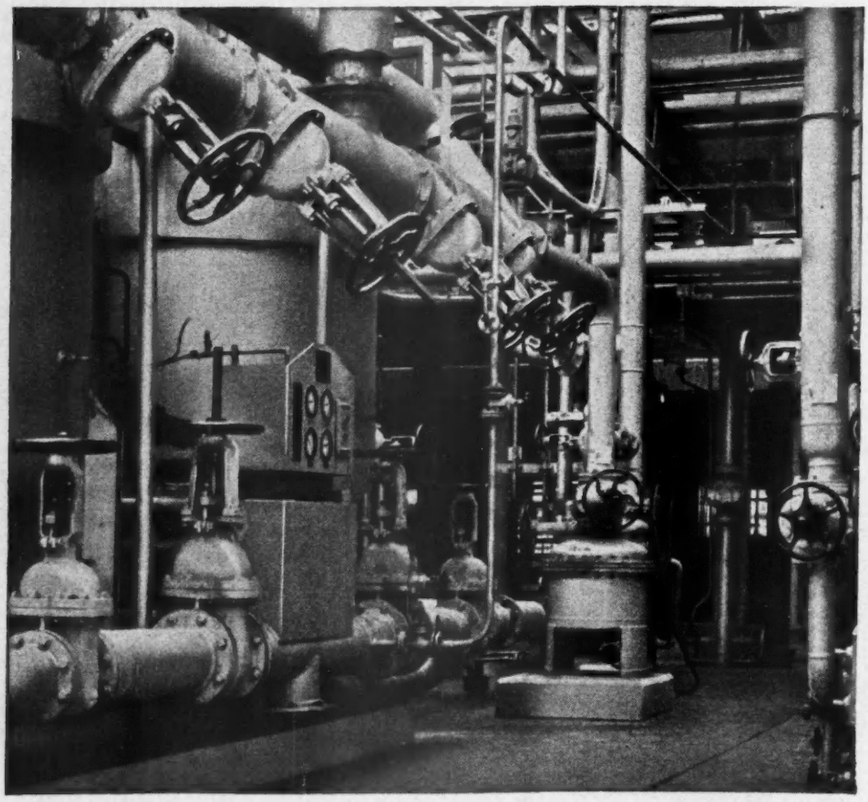
LONDON OFFICE:
251 Kingston Road, London, S.W.19 CHErrywood 3806/7

ABERDEEN *26062*
BELFAST *28967*
BIRMINGHAM 5 *Midland 4639*
BLACKBURN *6581*
BRADFORD *31114*
BRISTOL *27214*
CARDIFF *27026*
CARLISLE *21589*
CHESTER *21280*
COVENTRY *20088*
DUNDEE *26728*
EDINBURGH 1 *Waverley 4234*
GLASGOW C2 *Central 4595*
HARROGATE *67058*
HULL *52072*
IPSWICH *53023*
LEEDS 3 *20664/5*
LEICESTER *56260*
LEYTON *Leytonstone 6068*
LIVERPOOL *Royal 5202* and *1251*
MANCHESTER 3 *Blackfriars 0596*
MIDDLESBROUGH *44576*
NEWCASTLE-ON-TYNE 2 *27142* and *27942*
NOTTINGHAM *46562/3*
SHEFFIELD 1 *25529*
SOUTHAMPTON *21276*
STOKE-ON-TRENT *44021*
WAKEFIELD *4571*
WIMBLEDON *CHErrywood 3806/7*
Republic of Ireland:
DUBLIN, 35 Westland Row *66597* and *66518*

Once again, valves by Crane

D27R

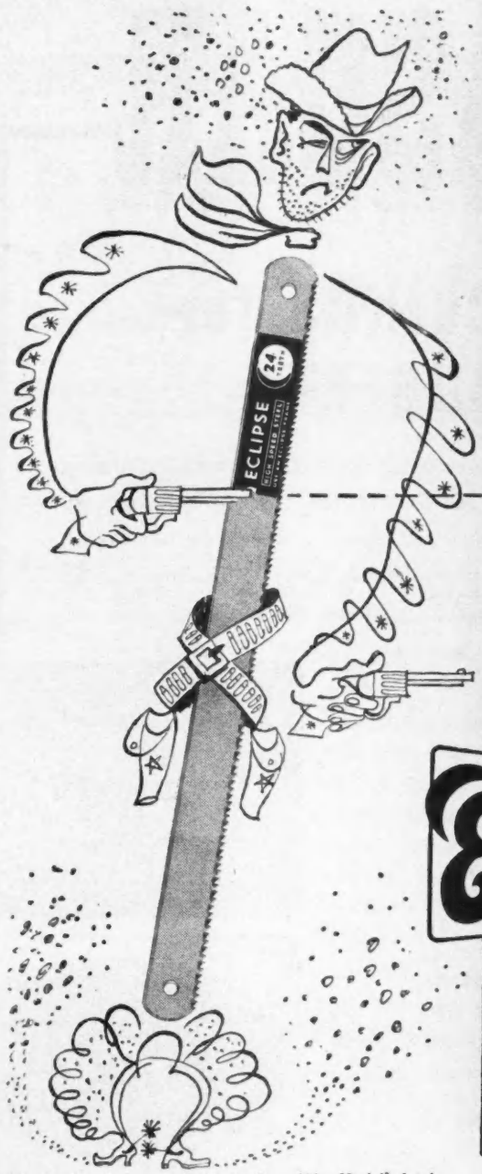
With the recent completion of yet another Olefine Plant at the Wilton Works of Imperial Chemical Industries Limited, there are now three in operation. In all of them Crane valves are performing duties under arduous conditions (extremes of temperature). In the plant illustrated here Crane steel valves up to 16-inch are employed. Industry is looking more and more to Crane valves for performance and dependability. The Crane reputation is founded on modern production methods, individual testing at the factory and the high grade materials which go into every one of the Crane products. This Plant was designed and installed by Kellogg International Corporation.



CRANE

VALVES OF BRONZE
CAST IRON AND STEEL

CRANE LTD., 15-16 RED LION COURT, FLEET ST., LONDON, E.C.4. Works: IPSWICH. *Branches: Birmingham, Brentford, Bristol, Glasgow, Leeds, London, Manchester*



For speed and long life...

STAND UP WHERE OTHERS FAIL

Eclipse

HACKSAW BLADES

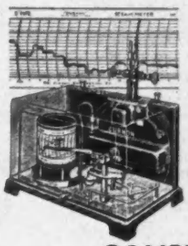
Made by James Neill & Co. (Sheffield) Ltd., and obtainable from all tool distributors

U.H.29

CUT THAT WASTE!

OF STEAM AND MONEY

WITH CURNON'S STEAM FLOW METERS & INDICATORS



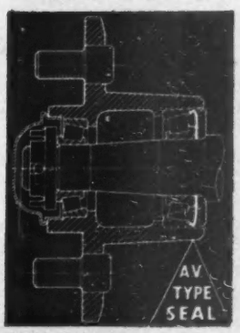
CUT YOUR COSTS IN THESE DAYS OF COMPETITION

FOR WATER, STEAM & AIR

SEND FOR FULLY ILLUSTRATED PAMPHLET

CURNON ENGINEERING CO.
CLAUDE ROAD WORKS
MANCHESTER 12. Tel.: CHORLTON 3885

Sealed for Longer Life...



MERCER

NILOS GREASE RETAINING SEALS

Of all metal construction and resistant to grit, dust, radio activity or high temperatures Mercer Nilos grease and oil seals are used by Europe's leading manufacturers for all types of bearings.

Only 3mm to 5mm *overall* thickness. English and metric sizes.

THOMAS MERCER LIMITED

of St. Albans, Hertfordshire.

Telephone ST. ALBANS

55313

REPRINTS

Single copies of these articles reprinted from ' Engineering ' are available from the publisher, 36 Bedford Street, London, WC2 free of charge:

Multileaf Spring Design (courtesy of Toledo Woodhead Springs Limited).

Design for an Ocean Going Research Ship, by H. F. P. Herdman, D.Sc., National Institute of Oceanography.

Hydrostatic Drives. An interview with Mr. E. H. Bowers, Director and Chief Engineer of Dowty Hydraulic Units Limited.

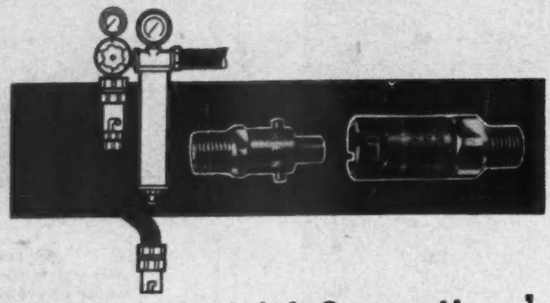
Performance of Jenbach Two-Stroke Oil Engines, by Professor S. J. Davies, D.Sc.(Eng.), Ph.D., M.I.Mech.E.

Reinforcement of Branch Pieces, by Dr. J. S. Blair, D.Sc., M.I.Mech.E., Mem.A.S.M.E. (Assistant Director Research, Stewarts & Lloyds Ltd.).

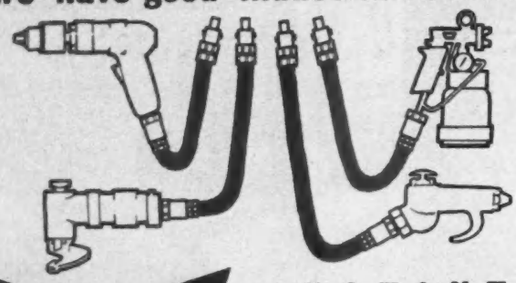
Hydrostatic Tractor Drive Easy to Handle—the Lucas System Described (courtesy Chamberlain Industries Limited).

maximum air flow–lowest pressure drop positive air seal — one hand operation

¼" ⅜" ½" sizes b.s.p. male and female connections



'We have good Industrial Connections'



B.E.N.

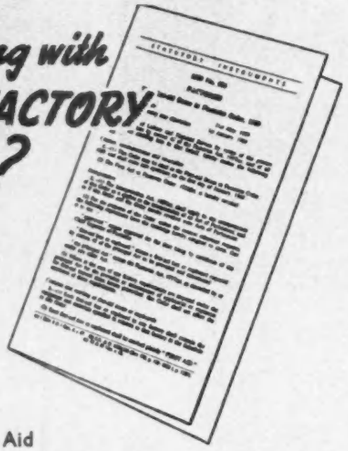
the symbol of quality

INSTANTAIR couplings

B.E.N. PATENTS LTD. (Division of Broom & Wade Ltd.)
Dept. C6. HIGH WYCOMBE, BUCKS.

C.P338

Are you complying with these REVISED FACTORY REGULATIONS?



Revised regulations regarding First Aid in Factories became effective from 1st January 1960.

As the Pioneers of Industrial First Aid we offer approved complete First Aid Outfits to meet the requirements of all trades.

Please state number of employees and nature of business when ordering.

Full details are available to responsible officials applying on their company's letterhead, mentioning this "Engineering" announcement.

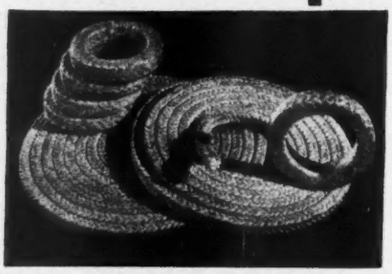
CUXSON, GERRARD & CO. LTD.
OLDBURY, BIRMINGHAM
Telephone: BROADWELL 1355 (5 lines)

LASCAR

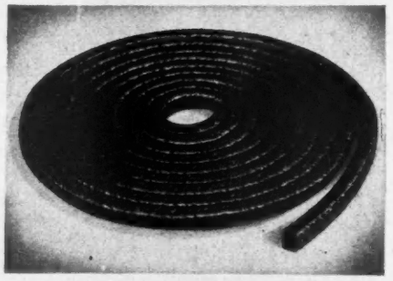
PACKINGS for INDUSTRY

The widely varying needs of Industrial Engineering are fully met from the range of LASCAR Packings. From water and steam to highly corrosive acids, tough, resilient, durable, LASCAR Packings meet all existing requirements and most new ones.

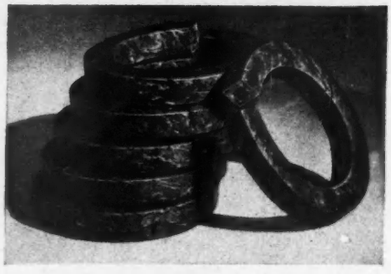
WHITE BELDAMOK
—The specially developed graphite-free packing for superheated steam at temperatures up to 1,100°F.



BELDAMOK
—The high grade asbestos packing lubricated for general high-temperature service up to 650°F.



BEDFORD
—a range of metal foil packings combining low friction with good resilience and designed for high speed rotating shafts.



Telephone or write for your copy of the LASCAR Manual—the best guide to better service in the application of jointings and packings.

BELDAM'S LASCAR PRECISION PACKINGS

BELDAM ASBESTOS COMPANY LIMITED
LASCAR WORKS, HOUNSLOW, MIDDLESEX
Telephone: HOUnslow 7722 (10 lines)

Pulsometer Pacific Pumps the pulse of industry

MAXIMUM PARTS INTERCHANGEABILITY IS A FEATURE OF PULSOMETER PACIFIC PROCESS PUMPS

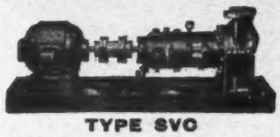
CORROSION ALLOWANCE All Pulsometer Pacific Process Pumps are built with case casting thickness in excess of actual pressure-temperature requirements. This provides a liberal allowance for corrosion-erosion and a high safety factor.

HEAVY CONSTRUCTION Pulsometer Pacific process pumps are engineered to combine the strength necessary for continuous heavy duty service with design simplicity and accessibility for low maintenance cost. All parts in contact with pumped liquid may be fabricated from any commercially available ferrous or non-ferrous metal.

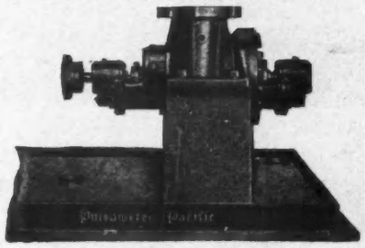
LONG LIFE Guided inlet flow reduces friction losses, insures minimum required NPSH. Dynamically, radially, and axially balanced moving parts eliminate vibration that would cause damage to rings, bushings, bearings, packing or mechanical shaft seals and excessive radial and thrust loads on bearings. The result is greatly increased availability for profitable operation.

INTERCHANGEABILITY Pulsometer Pacific Pumps are guaranteed interchangeable with those manufactured by Pacific Pumps Inc. of California, thus ensuring prompt and efficient service the world over.

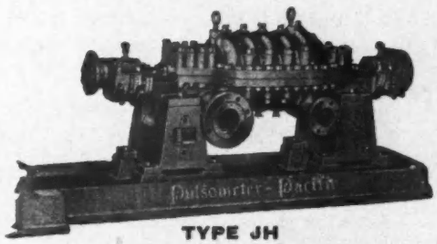
Send for illustrated leaflets.



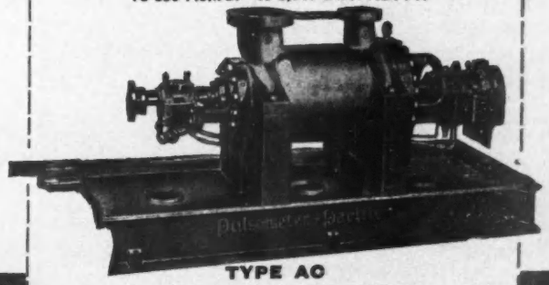
TYPE SVO
To 850° F.—20 to 2,700 G.P.M.
To 600 P.S.I.G.—to 600 DIFF. HD. FT.



TYPE HVO
To 850° F.—500 to 3,800 G.P.M.
To 600 P.S.I.G.—to 1,000 DIFF. HD. FT.



TYPE JH
To 500° F.—85 to 1,350 G.P.M.
To 850 P.S.I.G.—to 2,500 DIFF. HD. FT.



TYPE AC
To 850° F.—85 to 2,100 G.P.M.
To 1,000 P.S.I.G.—to 2,600 DIFF. HD. FT.

PULSOMETER ENGINEERING CO. LTD.
READING, BERKS. ***Telephone: Reading 67182***
London Office: Pulsometer House, 20-26 Lamb's Conduit Street, W.C.2 **Telephone: HOLborn 1402**

Pulsometer PACIFIC

(3519)

The "Margam Abbey"—built for the Port Talbot Pilotage Authority by Richard Ironworks Ltd., in which Cor-Ten was used extensively. Photograph by courtesy of the Port Talbot Pilotage Authority

COR-TEN GOES DOWN TO THE SEA IN SHIPS

At sea as well as ashore new uses are constantly being found for SCW Cor-Ten. It was used extensively in the construction of this vessel for the Port Talbot Pilotage Authority.

The Main Deck
Shell Plating and Anchor Recess
Floors and Engine Seating
Chain Locker
Fresh Water Tank
Bulkhead Bottom Plating
Rudder Side Plates

—were made entirely from Cor-Ten. A typical example of the growing use of Cor-Ten in marine construction, and in other fields where high yield strength, together with outstanding resistance to corrosion, is vital.

COR-TEN IS TOUGHER

Weight for weight, the yield strength of SCW Cor-Ten is 50% higher than ordinary mild steel.
Alternatively—
Strength for strength, a saving of 1/3 of the weight is possible.

4-6 times more resistant to atmospheric corrosion.
Highly resistant to abrasion and fatigue.

COR-TEN SAVES MONEY

Initial costs are spread over a longer service life.

Maintenance costs are reduced.

Operating costs are lowered—in transport, payloads are bigger because of reduction in tare weight.

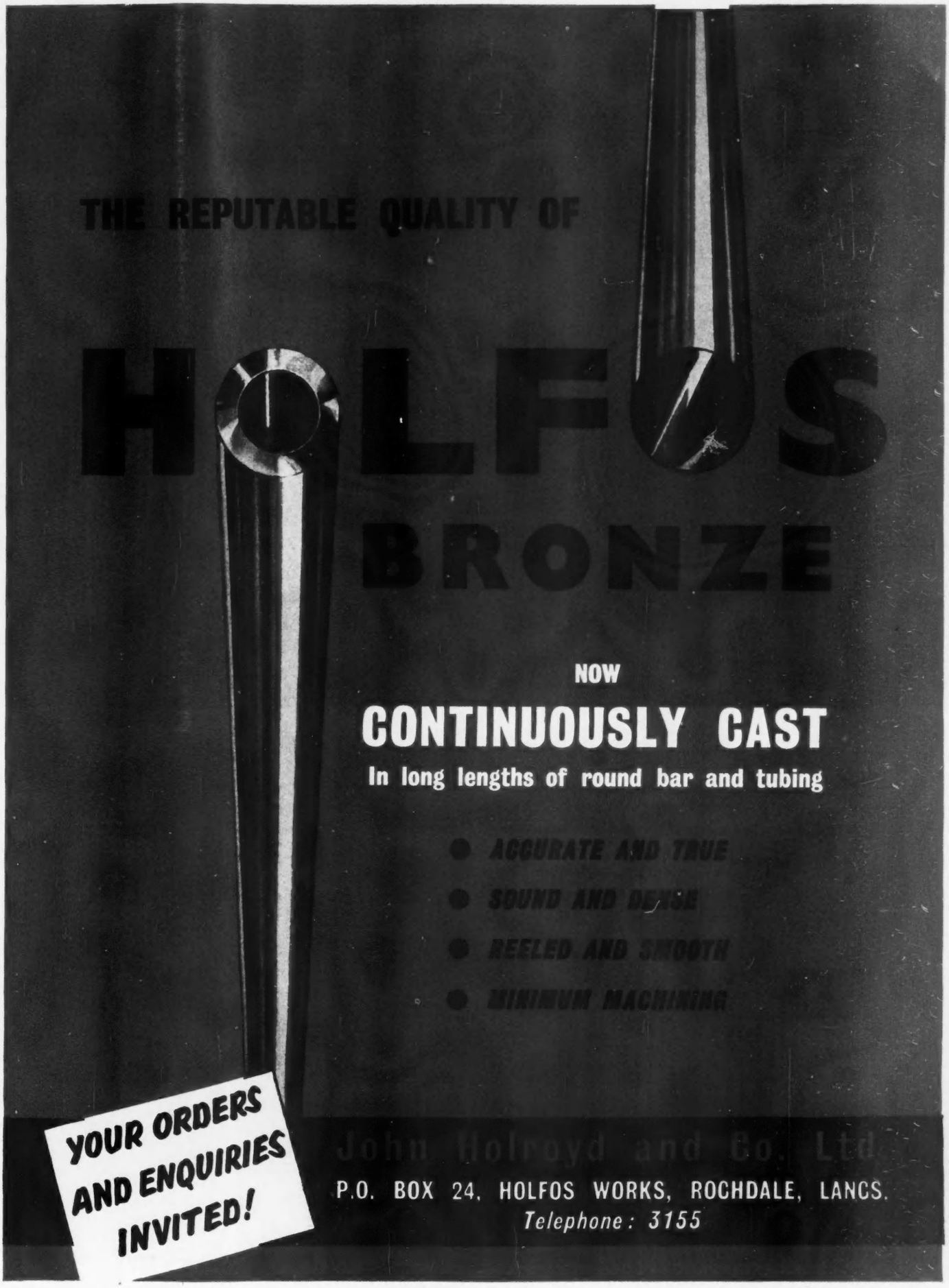
Please write to us at the address below for further information or for technical assistance in the application of SCW Cor-Ten to your products.

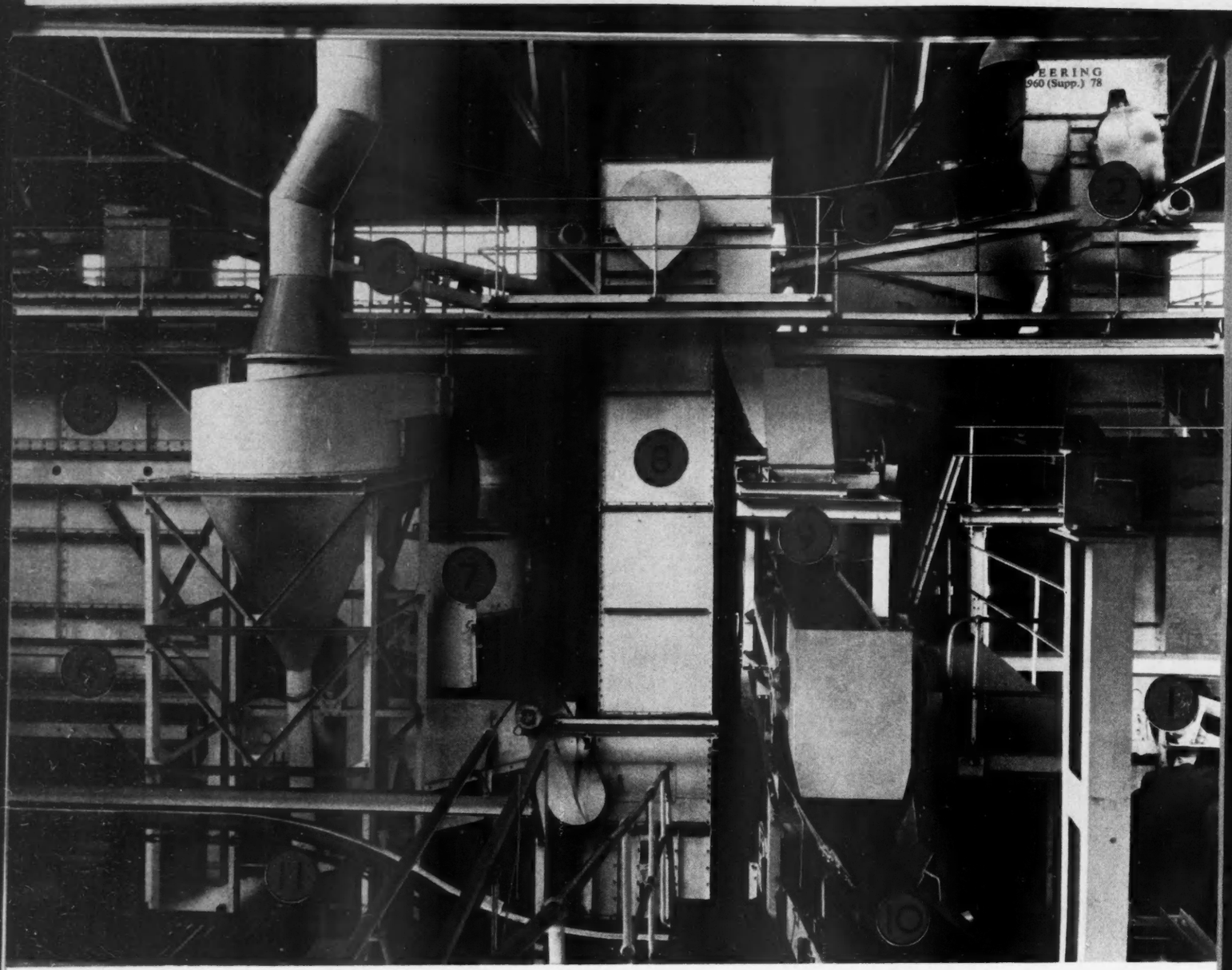
S·C·W BRAND Cor-Ten

RAILWAY ROLLING STOCK. AGRICULTURAL AND EARTH-MOVING EQUIPMENT. BARGES AND SMALL CRAFT MINE CARS. POWER STATION INSTALLATIONS

THE STEEL COMPANY OF WALES LIMITED

ABBEY WORKS, PORT TALBOT, GLAMORGAN. TELEPHONE: PORT TALBOT 3161


THE REPUTABLE QUALITY OF
HOLFOS
BRONZE
NOW
CONTINUOUSLY CAST
In long lengths of round bar and tubing
● ACCURATE AND TRUE
● SOUND AND DENSE
● REELED AND SMOOTH
● MINIMUM MACHINING
YOUR ORDERS AND ENQUIRIES INVITED!
John Holroyd and Co. Ltd.
P.O. BOX 24, HOLFOS WORKS, ROCHDALE, LANCS.
Telephone: 3155



The illustration shows that part of a **MORRIS** foundry sand and mechanization plant which re-conditions knocked-out sand. At **1**, sand coming from the knock-out via an apron plate and belt conveyor passes beneath a magnetic separator (to remove tramp iron) and falls into the boot of a belt-bucket elevator, **2**, discharging into screen **3** onto belt conveyor **4** which in turn discharges into sixty-ton storage hopper **5**. The flat belt conveyor, **6**, under the hopper, pours sand into the skip which feeds the mulling machine (known as the Speedmullor). This machine **7**, providing a rapid mulling cycle with close batch control, discharges the sand into belt-bucket elevator **8**. From thence, the sand proceeds via belt conveyors **9** and **10** to the moulders. The overhead chain conveyor **11** serves the core shop with sand and also takes the cores to the stoves and to the moulders.

MECHANICAL HANDLING EXHIBITION

EARLS COURT 3-13 MAY

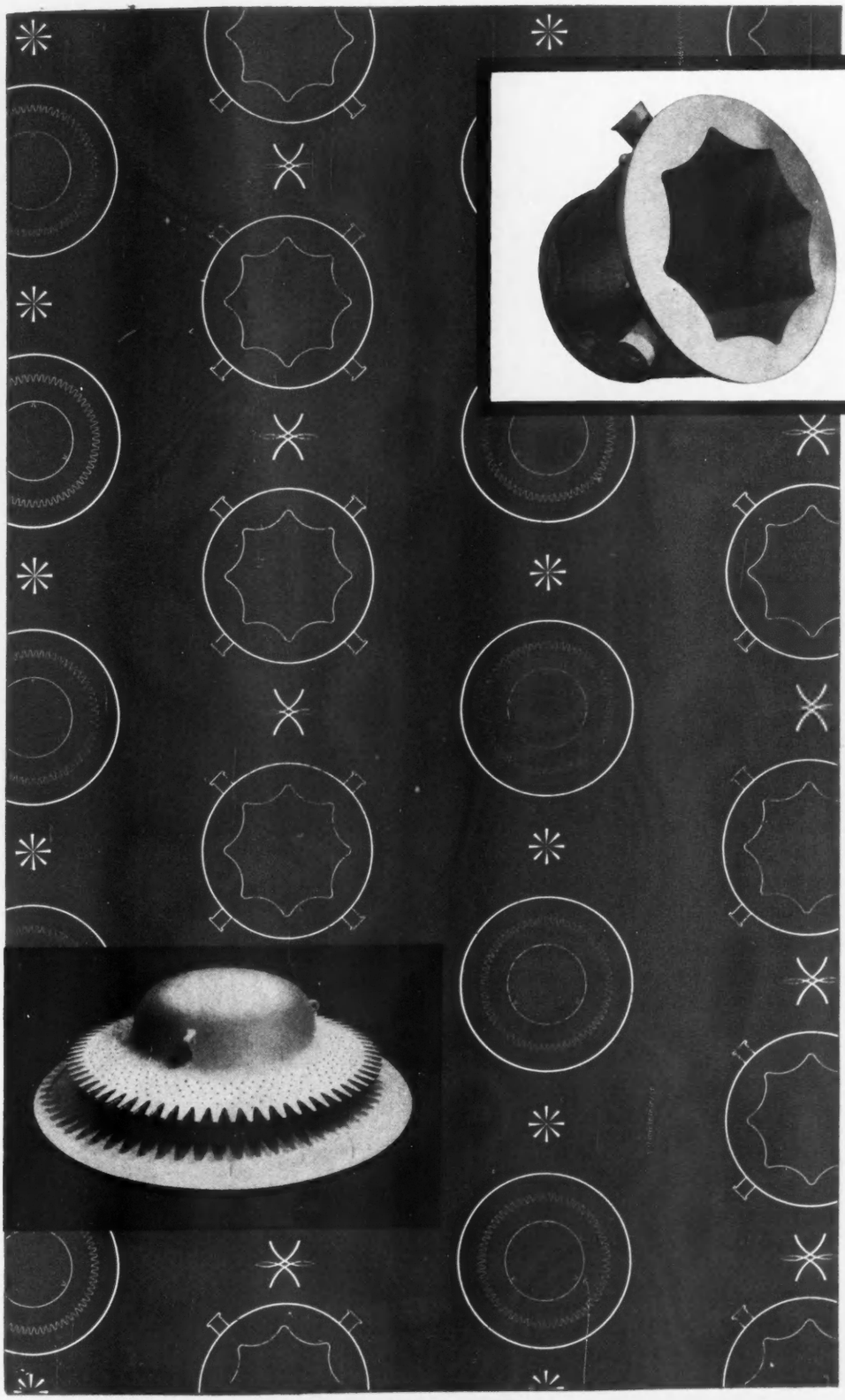
SEE OUR EXHIBIT ON STANDS H 12 and J 14

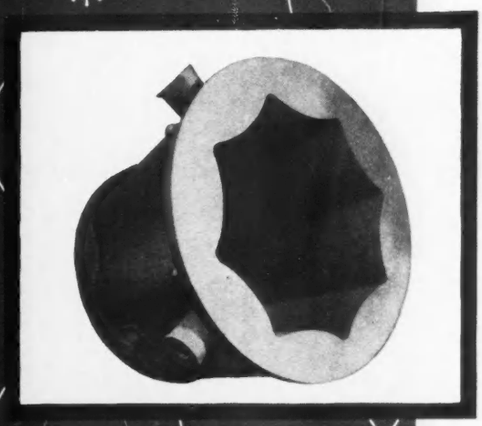
Consult MORRIS

FOR COMPLETE HANDLING SCHEMES FOR ALL INDUSTRIES

HERBERT MORRIS LTD P.O. BOX 7 LOUGHBOROUGH ENGLAND

TELEPHONE LOUGHBOROUGH 3123



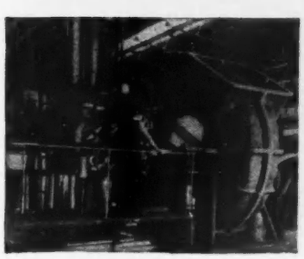


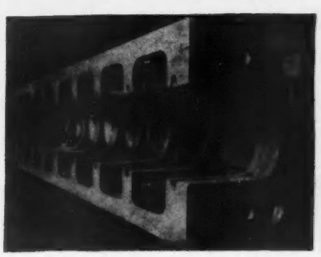
DISTINGTON

HEAVY CASTINGS

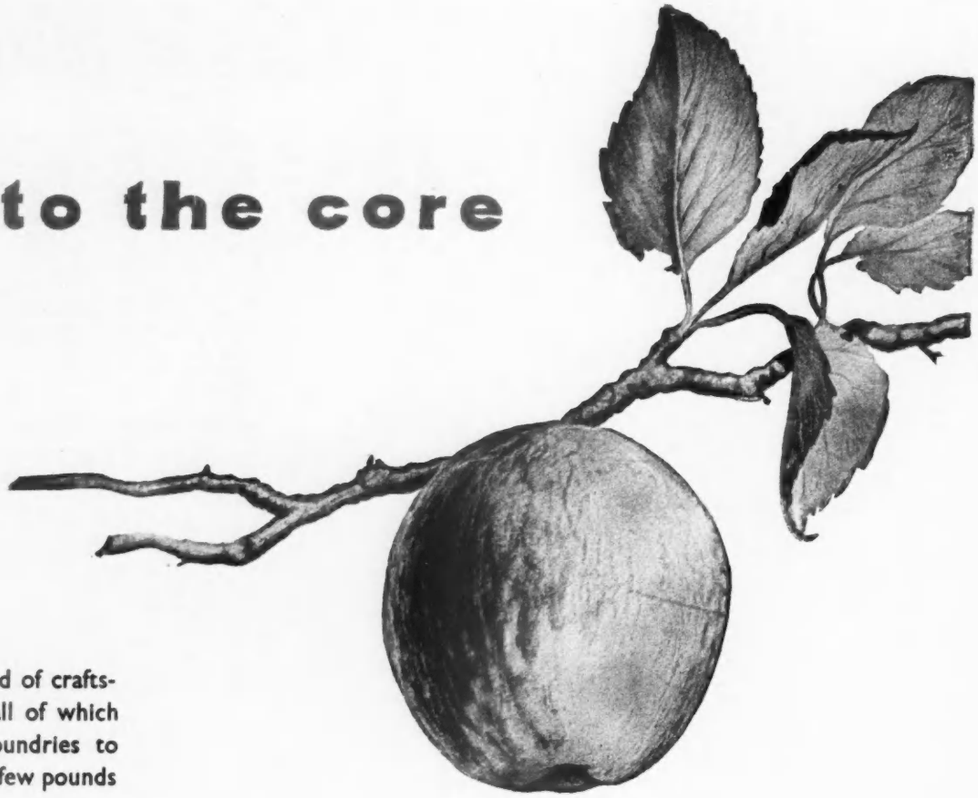
One of the largest foundries in the world is operated by Distington Engineering Company, which specialises in the production of heavy castings in hematite, grey and special irons.

DISTINGTON ENGINEERING COMPANY LIMITED
Workington, Cumberland





Sound to the core



Modern steel-founding is a blend of craftsmanship, art and technology, all of which are applied in the Osborn foundries to produce castings ranging from a few pounds to several tons in weight.

Castings in carbon and alloy steels are manufactured for many industries, including General Engineering, Mining, Quarrying, Oil Refining, Dredging, Chemical and Electrical Engineering. The Company's reputation as steelmakers ensures that only the finest steels are used for these castings, which are sound throughout and of the ultimate standard of quality.

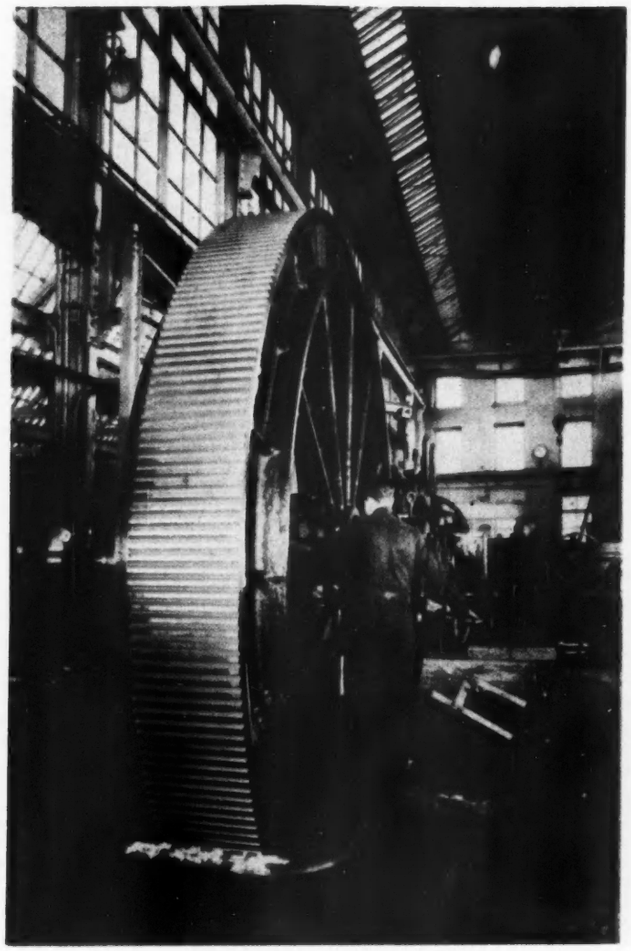
Osborn castings are used in this *Hayward Tyler—Byron Jackson six-stage 'Multiplex' pump.* Inset illustrates core used for casting the upper half of casing.

OSBORN

FINE STEELMAKERS • STEELFOUNDERS • ENGINEERS' TOOLMAKERS

SAMUEL OSBORN & CO., LIMITED

CLYDE STEEL WORKS, SHEFFIELD



CROFTS HAVE BIG IDEAS ON GEARS!

185" diam. 37" face width. 5" CP

We often find ourselves in this kind of company, because we specialise in heavy industrial gearing—Spur and Helical—Single and Double—for rolling mill equipment, steelworks plant, sugar and cement mill drives.

We do, however, spend much of our time in lesser company, as large-scale manufacturers for all branches of industry.

Our wide STOCK RANGE includes Spur and Mitre Gear Drives up to 70 h.p. and Bevel Gears up to 44 h.p. In addition, we produce Internal Gears, Racks and Pinions, Worms and Wheels, Spiral Bevels and Spiral Mitres.

Customers' blanks can also be cut, and gears manufactured to special order.

Write for our handy illustrated pocket size catalogue, Publication 159, giving full details and tables.

Crofts
REGD TRADE MARK

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

THORNBURY BRADFORD 3 YORKSHIRE *Telephone : 65251 (20 lines)*

Telegrams : "Crofters Bradford Telex" Telex 51186

BRANCHES AT : Belfast Birmingham Bristol Cardiff Dublin Glasgow Ipswich Leeds Liverpool London Manchester Newcastle Northampton Nottingham Sheffield Stoke-on-Trent

Subsidiary Companies in Canada, South Africa, U.S.A. *World-wide Representation*

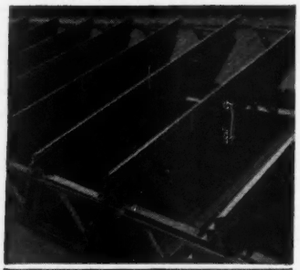
FOWLER FOR A WHALE OF A GOOD STEEL CASTING

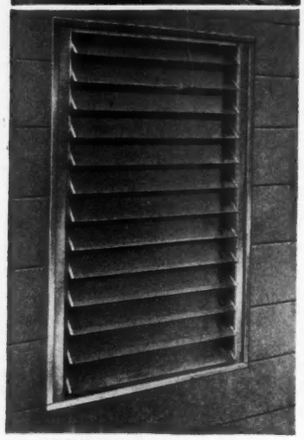
Technical brochure from
John Fowler & Co (Leeds) Ltd, Sprotborough Foundry, Sprotborough, Doncaster

balanced approach to ventilation

Efficient ventilation depends directly upon the balanced relationship of all factors involved. Outlet area, airflow velocity, overall volume, air temperature, seasonal fluctuations. These are some of the things to be considered before the type, location and number of ventilators is finalised. Hills are continuously achieving the efficient balance for foundries, rolling mills, factories, etc. Opening the way to better working conditions . . . *better* production. If ventilation is one of your headaches, let Hills Technical Department take it over.

Roof ventilating shutters.





Louvred air inlet ventilators.

HILLS (WEST BROMWICH) **LIMITED**

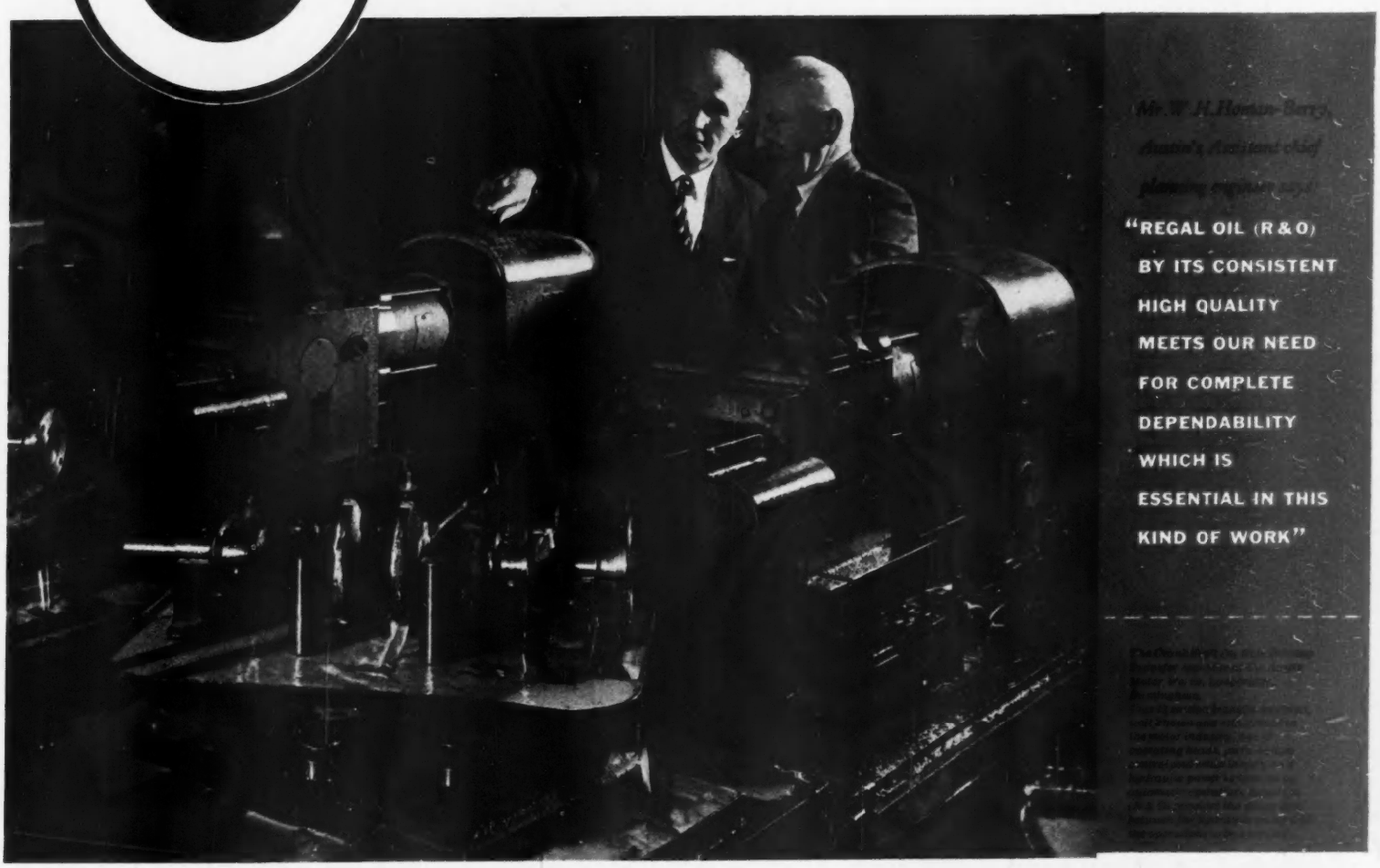
ALBION ROAD, WEST BROMWICH, STAFFS.
Telephone: West Bromwich 1811 (15 lines).

London: Chapone Place, Dean Street, W.1.
Telephone: GERrard 0526/9.
Branches at: Manchester, Bristol, Newcastle-on-Tyne, Glasgow.

V6

The Austin MOTOR COMPANY LTD choose

REGENT REGAL HYDRAULIC OILS



"REGAL OIL (R & O) BY ITS CONSISTENT HIGH QUALITY MEETS OUR NEED FOR COMPLETE DEPENDABILITY WHICH IS ESSENTIAL IN THIS KIND OF WORK"

5 special features make Regent Regal (R & O) Oils invaluable for all hydraulic operations

INCREASING USE IN BRITISH INDUSTRY

To operate efficiently, even the simplest hydraulic system must be kept absolutely clean. This means that wear must be reduced, rust eliminated and gum and sludge deposits prevented.
Regal Oils (R & O) do all this, and give long-lasting protection to all industrial hydraulic systems.
Which is why more and more British industries are turning to Regal Oils (R & O) for high quality performance and complete dependability.

RESIST OXIDATION

Regal Oils (R & O) contain powerful oxidation inhibitors which minimise the possibility of gum or sludge deposits and increase intervals between drain periods.

PREVENT RUST

Regal Oils (R & O) contain a rust inhibitor which 'plates out' on metal surfaces, forming a tenacious film that is impervious to rusting action of moisture and water. This eliminates the damage so often caused by rust.

PREVENT WEAR

Regal Oils (R & O) cling to metal surfaces and penetrate between closely fitted bearing surfaces, giving adequate lubrication. This way wear is minimised.

ANTI-FOAMING

Regal Oils (R & O) are processed so that they are highly resistant to foaming. This characteristic is improved by additive treatment.

WIDE VISCOSITY RANGE

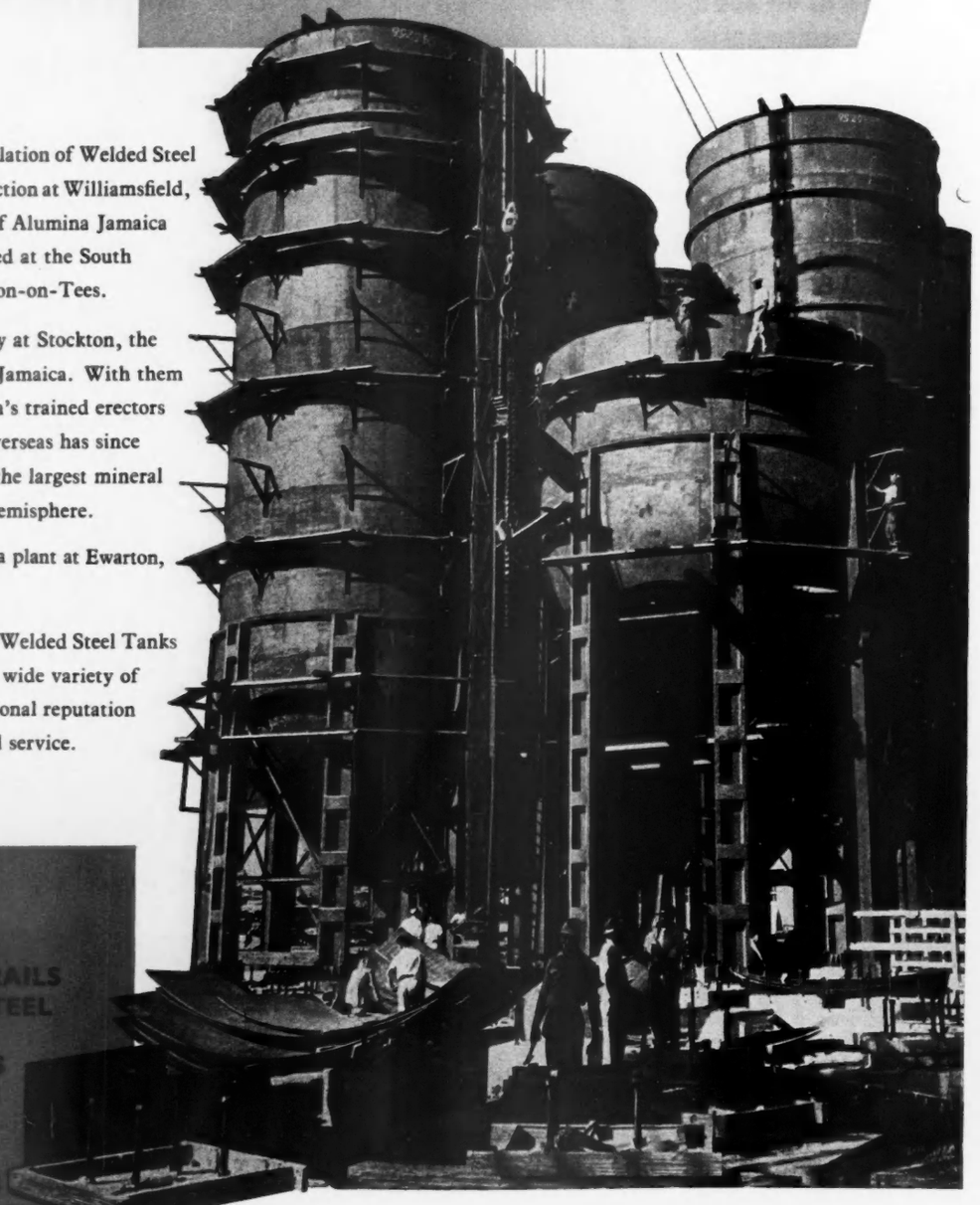
Regal Oils (R & O) are manufactured in different viscosity grades to meet every operating condition and give excellent performance at both high and low temperatures.
Regent Regal Oils (R & O) meet the requirements of the British Hydraulic Pump Manufacturers. The range comprises:
Regal Oil A (R & O) Regal Oil B (R & O). Regal Oil CC (R & O). Regal Oil C (R & O). Regal Oil PC (R & O). Regal Oil PE (R & O) (R & O) Oil AA.

REGENT

REGENT OIL COMPANY LTD., 117 PARK STREET, LONDON, W.1

STEEL PRODUCTS OF INTERNATIONAL REPUTE

South Durham in JAMAICA



Here is one small part of an installation of Welded Steel Precipitator Tanks in course of erection at Williamsfield, Jamaica, at the Kirkvine Works of Alumina Jamaica Ltd. The tanks were manufactured at the South Durham Malleable Works, Stockton-on-Tees.

After fabrication and test assembly at Stockton, the component parts were shipped to Jamaica. With them went a full crew of South Durham's trained erectors and welders whose tour of duty overseas has since covered the installation of one of the largest mineral processing plants in the western hemisphere.

Work on a similar Alumina Jamaica plant at Ewarton, has also been recently completed.

All over the world, South Durham Welded Steel Tanks and Pressure Vessels are serving a wide variety of industries and maintaining the national reputation for high quality products and good service.

Other South Durham manufactures include:
STEEL PLATES · STEEL RAILS AND ACCESSORIES · STEEL JOISTS AND SECTIONS BROAD FLANGE BEAMS LARSSEN STEEL PILING 'RENDHEX' FOUNDATION COLUMNS · STEEL PIPES STRUCTURAL STEELWORK ELECTRICALLY WELDED FABRICATIONS

The services of the South Durham Technical Advisory and Drawing Office Staffs are available at all times to engineers engaged in the planning or development of projects involving the use of any of the Company's products.

SOUTH DURHAM STEEL AND IRON COMPANY LIMITED

Central Sales Office: **CARGO FLEET IRON WORKS, MIDDLESBROUGH, YORKS.**

Telephone: Middlesbrough 46311 (13 lines). Telex: 58551. Telegrams & Cables: "Soudurham," Middlesbrough, Telex. Also at West Hartlepool, Stockton-on-Tees & London.

Lubrication Plus Protection

Mobilux Grease is a lithium-base lubricant of excellent structural stability and purity. It is a new, general-purpose grease superseding conventional greases. It provides effective lubrication for the majority of grease applications over a temperature range from minus 20°F to 250°F. It is exceptionally resistant to water washing and contains special additives to prevent rust formation. Both in the laboratory and in the field Mobilux Grease has proved its outstanding efficiency as a lubricant and protector.

MOBILUX GREASE

Mobil

ECONOMY SERVICE

INDUSTRIAL LUBRICANTS

L

When Replacing Obsolete STEAM BOILERS

INSTAL THE FRASER WATER-TUBE BOILER

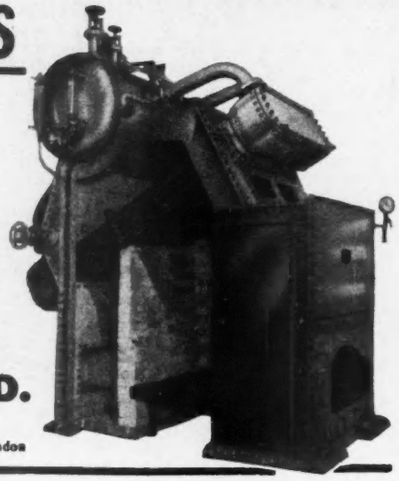
Unsurpassed for efficiency and versatility, the Fraser Boiler has the distinctive merit that it incorporates a large brick-lined smoke consuming combustion chamber, thus complying with the requirements of the Clean Air Act.

Write for illustrated literature

FRASER & FRASER LTD.

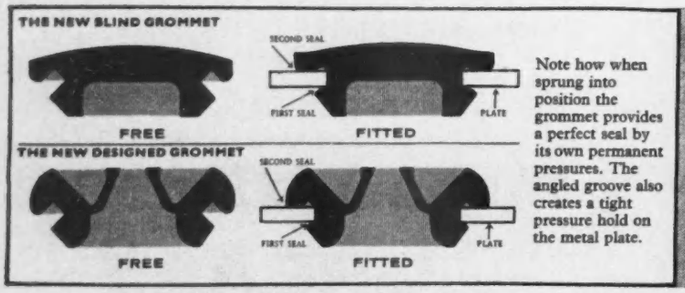
Bromley-by-Bow, London, E.3

Telephone: ADVance 3266 (4 lines) Telegrams: Pressure, Easphone, London

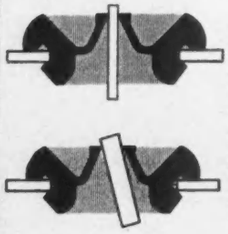


THE EMPIRE RUBBER SELF-CONFORMING GROMMET
. . . is the solution to many an engineering problem

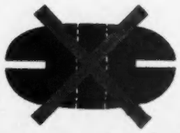
PAT. APP. No. 5255/59



Note how when sprung into position the grommet provides a perfect seal by its own permanent pressures. The angled groove also creates a tight pressure hold on the metal plate.



A useful feature of this cable grommet is that by reason of the designed taper of the cable entry and the flexibility of the web, a considerable angle of cable entry and a variety of cable size, are possible. This avoids necessity for special grommets with angled bores.



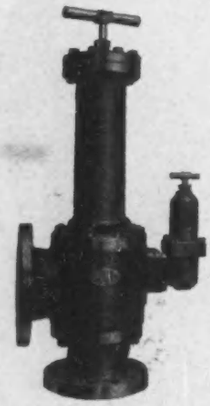
In the conventional grommet, only one thickness of plate and only one size of cable can be accommodated. No effective seal is afforded by the parallel groove.

This new development in grommets is now being produced in a range of sizes
These new grommets will solve your sealing problem

Enquire for catalogue and detailed particulars.

EMPIRE RUBBER COMPANY, DUNSTABLE, BEDFORDSHIRE, ENGLAND RB103

AULD



Patent Full Bore Safety Valve

FIT AULD'S PATENT REDUCING VALVES for all duties on Steam, Air or Water Services

AULD'S PATENT Full Bore Safety Valve enables full area of seat to be utilised for discharge

Class "A" Reducing Valve

We also manufacture

SURPLUS VALVES, COMBINED SURPLUS AND REDUCING VALVES, STOP VALVES, STEAM TRAPS, DE-SUPERHEATERS, COMBINED REDUCING AND DE-SUPERHEATING UNITS

DAVID AULD & SONS LTD.

Whitevale Foundry, GLASGOW.

Telephone No. Bridgeton 1242 Telegrams: "Reducin" Glasgow

The meaning of SMITHS in Production Planning

FOR IMMEDIATE DELIVERY

An hours counter gives you an exact record of running times of mains powered electric equipment or machinery. This enables you to apply planned maintenance schemes resulting in increased efficiency—and reducing production stoppages. For counting the hours fit a . . .

SMITHS Synchronous Counter

- 10,000 hrs Total Count; 1,000 hrs 'Trip' Count indicating in tenths can be included
- Pressed-steel case to withstand rough handling
- Precision-machined internal gearing for smooth running and self-starting
- High-torque, self-starting, synchronous 2-watt motor available for 50 or 60 cycle supplies of 12, 100/125, 200/250 V

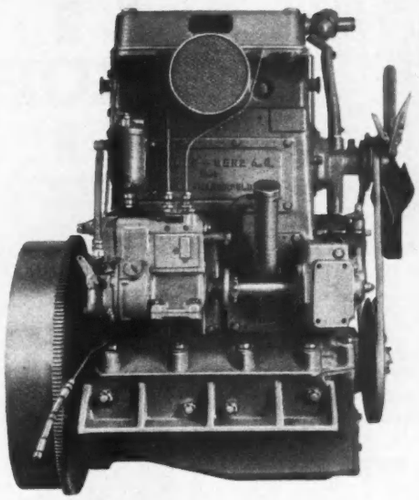
Write now to:-

SMITHS INDUSTRIAL INSTRUMENT DIVISION

Chronos Works, North Circular Road, London, N.W.2 Telephone: GLAdstone 1136

AP/404

A range of engines for all requirements



Mercedes-Benz Diesel engines have the same characteristics which distinguish all Daimler-Benz products: high performance, economy, sturdy construction and long life. The wide range of Diesels produced by Daimler-Benz consists of 34 engines ranging from 20 to over thousand PS. There is a Mercedes-Benz Diesel engine for almost every power requirement in industry and commerce: be it for fork-lift trucks, cranes or excavators, generators for emergency or main power supply, compressors, pumps, or to supply highly mobile power to drive all sorts of machinery and tools.

Types and Performance Data Type	Cooling	No. of cylinders Arrangement	Output PS (DIN)	Speedrange R.P.M.	Cyl. Bore ins.	Stroke ins.	Piston displacement cu. ins.	Weight approx. lbs.
M 202 B	W	2/S	35 – 55	750 – 1200	5 1/2	8 1/4	394.8	1665
M 203 B	W	3/S	54 – 90	750 – 1200	5 1/2	8 1/4	591.9	2150
M 204 B	W	4/S	72 – 120	750 – 1200	5 1/2	8 1/4	789.0	2715
OM 636	W	4/S	17 – 35	1500 – 3000	2 15/16	3 15/16	107.8	495
OM 312	W	6/S	47 – 77	1500 – 2400	3 9/16	4 3/4	279.5	784
OM 321	W	6/S	55 – 94	1500 – 2600	3 3/4	4 3/4	311.2	784
OM 315	W	6/S	80 – 124	1200 – 1800	4 7/16	5 1/2	505.0	1700
OM 326	W	6/S	97 – 155	1200 – 1800	5 3/64	5 1/2	660.0	1720
MB 851	W	1/S	9 – 20	1000 – 2000	4 1/2	5 1/2	88.8	662
MB 861	L	1/S	9 – 20	1000 – 2000	4 1/2	5 1/2	88.8	662
MB 852	W	2/S	18 – 40	1000 – 2000	4 1/2	5 1/2	176.9	915
MB 862	L	2/S	18 – 40	1000 – 2000	4 1/2	5 1/2	176.9	915
MB 853	W	3/S	27 – 60	1000 – 2000	4 1/2	5 1/2	266	1122
MB 863	L	3/S	27 – 60	1000 – 2000	4 1/2	5 1/2	266	1122
MB 854	W	4/V	36 – 80	1000 – 2000	4 1/2	5 1/2	354.4	1245
MB 864	L	4/V	36 – 80	1000 – 2000	4 1/2	5 1/2	354.4	1245
MB 846 A	W	6/S	114 – 250	750 – 1500	5 7/8	7 1/2	1230.2	3860
MB 846 B	W	6/Li	114 – 250	750 – 1500	5 7/8	7 1/2	1230.2	3970
MB 846 Ab ▽	W	6/S	148 – 320	750 – 1500	5 7/8	7 1/2	1230.2	4080
MB 846 Ad ▼	W	6/S	148 – 320	750 – 1500	5 7/8	7 1/2	1230.2	4200
MB 846 Bb ▽	W	6/Li	148 – 320	750 – 1500	5 7/8	7 1/2	1230.2	4200
MB 836 B	W	6/S	240 – 375	1000 – 1500	6 7/8	8 11/16	1806.3	4380
MB 836 Bb ▽	W	6/S	320 – 525	1000 – 1500	6 7/8	8 11/16	1806.3	4830
MB 836 Db ▼	W	6/S	370 – 650	1000 – 1500	6 7/8	8 11/16	1806.3	5050
MB 820 B	W	12/V	460 – 750	1000 – 1500	6 7/8	8 11/16	3612.6	6180
MB 820 Bb ▽	W	12/V	640 – 1100	1000 – 1500	6 7/8	8 11/16	3612.6	6900
MB 820 Db ▼	W	12/V	770 – 1350	1000 – 1500	6 7/8	8 11/16	3612.6	7240
MB 837 A	W	8/V	165 – 440	1000 – 2000	6 1/2	6 7/8	1825	2940
MB 837 Aa ▽ ▽	W	8/V	215 – 550	1000 – 2000	6 1/2	6 7/8	1825	3020
MB 835 Ab ▽	W	12/V	840 – 1450	1000 – 1500	7 1/2	9 1/2	4773	8157
MB 835 Bb ▼	W	12/V	1015 – 1780	1000 – 1500	7 1/2	9 1/2	4773	8597
MB 839 Ab ▽	W	16/V	1120 – 2000	1000 – 1500	7 1/2	9 11/16	6380	11020
MB 839 Bb ▼	W	16/V	1350 – 2400	1000 – 1500	7 1/2	9 11/16	6380	11450
MB 518 B ▼ ▼	W	20/V	3000	1720	7 5/16	9 3/16	8201.5	10550

Note:
W = water cooling L = air cooling
Li = horizontal S = vertical
V = vee type ▽ = with exhaust-turbo-supercharging ▼ = with exhaust-turbo-supercharging and boost intercooling ▽ ▽ = with mechanical supercharging
▼ ▼ = with mechanical supercharging and boost intercooling

MERCEDES-BENZ DIESEL

L 2

WELDED STEEL PLATEWORK
In ⅛" to ½" thick Mild Steel

PRESSURE VESSELS
TANKS & CYLINDERS
CHIMNEYS
DRYERS
HOPPERS
CYCLONES
BEDPLATES
ANGLE & FLAT BAR RINGS

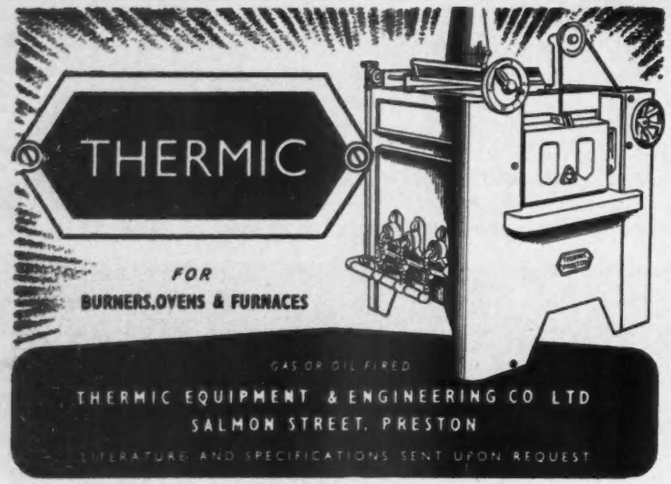
C & M ENGINEERING CO LTD

THAMES Rd. BARKING, ESSEX
TELEPHONE: RIPpleway 3011-2

The perfect joint compound for all screwed pipe joints

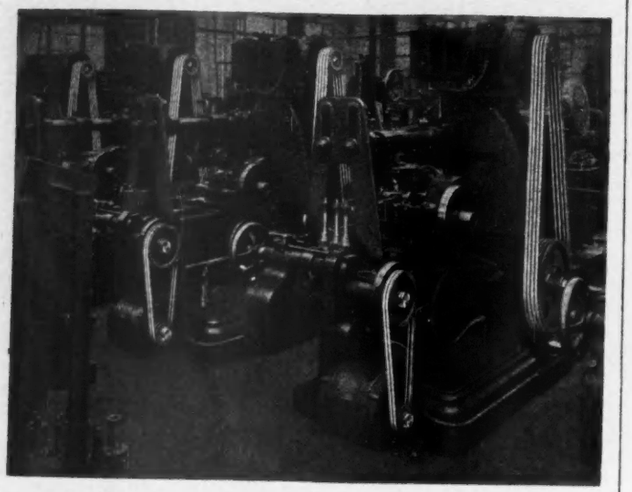
also for : Vee-Reg Valves
Velan Steam Traps
and all pipe-line accessories
Write to :—

The British Steam Specialties
LIMITED
Fleet Street, Leicester
— and Depots —



a century of experience in

V-ROPE DRIVES



Thrapston V-Rope Drives are designed to give maximum efficiency, long life and flexibility, producing trouble-free smooth, silent, clean running.

SMITH & GRACE Ltd.

THRAPSTON, NEAR KETTERING
Telephone: THRAPSTON 531-532
Telegrams: "GRACE" Thrapston

You buy a ***PRESS BRAKE***

FOR THE SPECIAL WORK IT PRODUCES

then choose the entirely *NEW BESCO-TRUEBEND* ALL-STEEL PRESS BRAKE

for your light and medium sheet metal bending and section forming and be very satisfied with the results—nine sizes, in 20, 40, 60 and 80 tons capacities.

Their versatility is remarkable; in addition to forming in individual or progressive operations, using single or multiple dies and attachments, they will corrugate, bead, seam and wire; punch, notch, blank and pierce; emboss and press. Auxiliary equipment includes gauges and punching units.

Besco-Truebend Press Brakes are of steel plate construction, designed and built using only the best of to-day's features, materials and methods. **Our leaflet 62M describes them fully and leaflet BP459 tells of the FJE Machine Hire Plan to give you this new plant with no capital expense.**

You should have these publications.

May we send them to you?

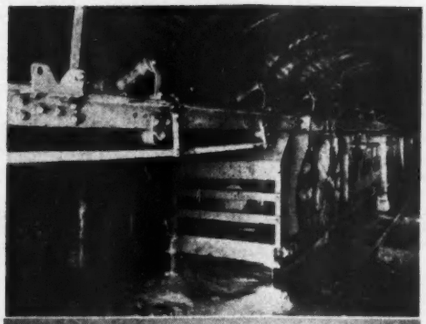
Registered Design No. 893331
Besco-Truebend is a registered name.

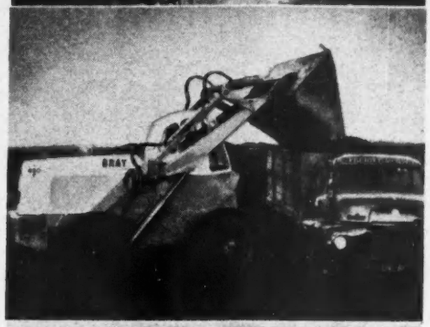
International MACHINE TOOL Exhibition OLYMPIA June 23 – July 6
STAND 8 GRAND HALL

F.J.Edwards Ltd

EDWARDS HOUSE, 359-361 EUSTON ROAD, LONDON, N.W.1
Phones: EUSTON 4681 (7 lines) 3771 (4 lines) Grams: Bescotools, London, NW1
LANSDOWNE HOUSE, 41 WATER STREET, BIRMINGHAM, 3
Phones: CENTRAL 7606 8 Grams: Bescotools, Birmingham, 3

Model No. Tons x die length	20/72	40/72	40/96	40/120	60/72	60/96	60/120	80/96	80/120
Bending capacity between frames	48" x 14S.W.G.	48"x⅛"	72"x⅛"	96" x 14S.W.G.	48"x¼"	72"x⅛"	96"x¼"	72"x¼"	96"x⅛"
Overall length	72" x 16S.W.G.	72"x¼"	96" x 14S.W.G.	120" x 16S.W.G.	72"x⅛"	96"x¼"	120" x 12S.W.G.	93"x⅛"	120"x¼"





TRANSMISSIONS for INDUSTRY

Conveyors, Mixing Machines, Versatile Tractors, Giant Cranes, are typical applications to which our units are applied. Transmission Specialists for over thirty years, we have pioneered, produced and perfected many different forms of transmission systems. Our experience is available to *help you solve your transmission problems.* Write to us for details of our interesting units for industry.

Acknowledgments to the following Companies:—

Richard Sutcliffe Ltd.
Baker Perkins Ltd.
Bray Construction Equipment Ltd.
Steel & Co. Ltd.

SELF-CHANGING GEARS LIMITED
PATENTEES AND MAKERS OF WILSON GBARBOXES
LYTHALLS LANE - COVENTRY - ENGLAND

More and more * industries are taking a liking to JOY LIMBEROLLERS

Europe's biggest gasworks, Britain's biggest cement manufacturers, fertilizer factories, foundries, mines, gravel pits and quarries . . . All over Europe, Joy Limberollers are taking the limelight as the *nearest technically perfect idler yet devised.* Only two self-lubricating bearings; flexible steel cable suspension; perfect catenary belt support; non-wearing, non-inflammable Neoprene roller, non-spilling, 'cushioned' ride.

These and many other advantages pinpoint British-made Joy Limberoller idlers as the biggest advance in materials handling in years.

AND YOUR APPLICATION . . . ?

Soft Ores? Chemicals? Gravel? Salt? Quenching Coke? Flour? Semi-liquids? Cement? Very few materials can defeat a Limberoller conveyor. See how Limberollers would cut your materials handling by writing for informative 8-page booklet . . . . . .

AND MORE ARE JUST ABOUT TO . . .

Limberoller idlers are now available with modifications for rope conveyor systems. If you use rope conveyors the new LIMBEROPE publication should be at your elbow. Please ask for a copy.

JOY · SULLIVAN LTD

CAPPIELOW · GREENOCK · SCOTLAND
EXPORT SALES: 7 HARLEY STREET, LONDON, W.1.

Your local Limberoller distributor:—

SCOTTISH
Potter & Cowan & Co. Ltd., 54 French Street, Glasgow, S.E.2. Bridgeton 7131

NORTHERN
Hill Porter (Newcastle) Ltd., G Pit Yard, Wallsend-on-Tyne Wallsend 64002

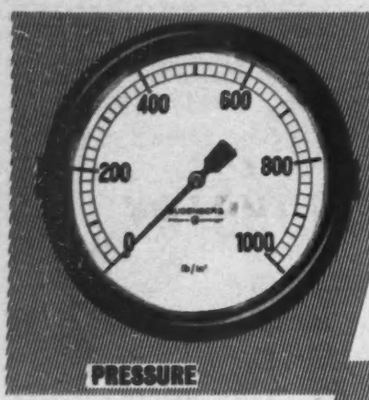
NORTH EASTERN
Glover & Wood Ltd., Victoria Works, Victoria Road, Leeds, 11. Leeds 36071

MIDLAND
Central Manufacturing & Trading Co. (Dudley) Ltd., Halesowen Road, Old Hill, Staffs. Cradley Heath 69434

NORTH WESTERN
Atlantic Rubber Co. Ltd., Atlantic Street, Broadheath, Altrincham, Cheshire Altrincham 3727

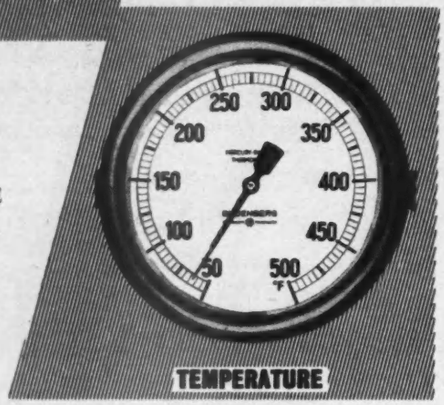
SOUTH WESTERN
M.Q.C. Equipment, Chesterfield Chambers, Westbourne Place, Bristol, 8 Bristol 39405

SOUTH EASTERN
Southern Industrial Rubber Ltd., 1 High Street, South Norwood, London, S.E.25 LIVingston 5560



FLUSH MOUNTING
PRESSURE GAUGES
and
THERMOMETERS

- ACCURATE
- GOOD APPEARANCE
- FULLY MATCHING
- EASILY FIXED
(by a single clamp)



Budenberg

BUDENBERG GAUGE CO. LTD
BROADHEATH Nr. MANCHESTER

dm BU43

THISTLEBOND
REPAIR KIT

for lasting emergency repairs to pipes, tanks, plating, machinery parts, etc.

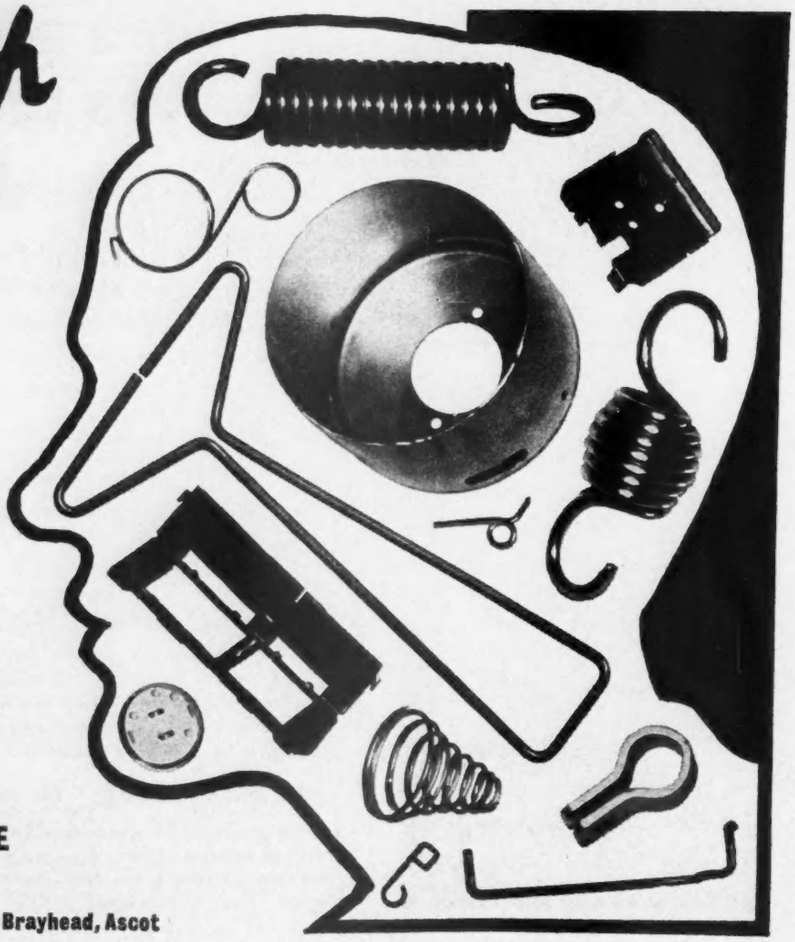
Complete to the last detail. Repairs are effected by a combination of tough-setting resin and activator, with glass fibre reinforcement. Thistlebond repairs have saved hundreds of pounds in dismantling costs and lost production time avoided.
An obvious safeguard for every work, ship, power installation, hospital, etc.

Full particulars from:

FERGUSON & TIMPSON LTD
5, ATHOLL AVENUE, HILLINGTON, GLASGOW, S.W.2.
Telephone: HALfway 4691 (5 lines)
155 MINORIES, LONDON, E.C.3

Be ahead with
BRAYHEAD

Springs, Pressings, Clips, Wire forms of all types are just a few of our highest quality products.
Delivery, prices, specifications and designs to suit all leading industries.
Why not take advantage of our advanced experience in this specialised field and stay in front of your competition?
Call for our advice on any problem or design, which our team of experts can solve and produce by efficient methods.



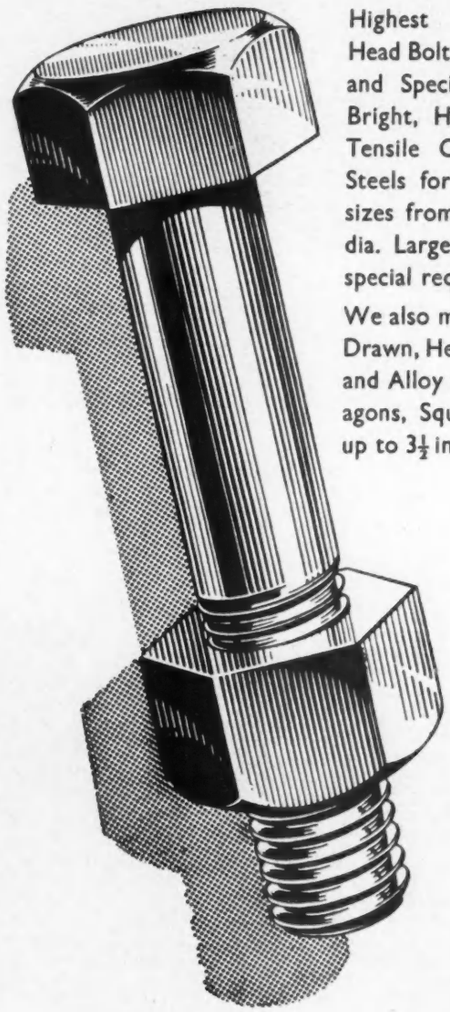
BRAYHEAD (ASCOT) LTD.

KARATEPI WORKS · KENNEL RIDE
ASCOT · BERKS

Telephone: Winkfield Row, 427/8 or Ascot 1907/8/9. *Telegrams:* Brayhead, Ascot

Marwin

BRIGHT & HIGH TENSILE bolts



Highest quality Hexagon Head Bolts, Nuts, Studs, Sets and Special Parts etc, in Bright, Heat Treated High Tensile Carbon and Alloy Steels for all industries, in sizes from ¼ in. up to 3 in. dia. Larger sizes supplied to special requirements.

We also manufacture Bright Drawn, Heat Treated Carbon and Alloy Steel Bars in Hexagons, Squares and Rounds up to 3½ in. dia.

HIGH TEMPERATURE "CREEP" RESISTING STUD BOLTS

Specialised products that give great resistance when exposed to high temperatures.

Sizes range from ⅜ in. to 3 in. dia.

Full technical details and Catalogue on request.

W. MARTIN WINN LTD.

DARLASTON . SOUTH STAFFS

Phone: JAMES BRIDGE 2072 (5 lines) *Grams: "ACCURACY" DARLASTON*

VALVES & COCKS

WE OFFER 125 YEARS OF EXPERIENCE IN THE DESIGN AND MANUFACTURE OF VALVES AND COCKS

NEW 150 PAGE CATALOGUE AVAILABLE

ROBERT HARLOW & SON LIMITED

HEATON NORRIS · STOCKPORT · CHESHIRE

Telephone: STOckport 3403/4/5

London Office: 10, Norfolk Street, W.C.2

Telephone: COVent Garden 0315/6/7

..FOR A DRIP-PAST A

GENUINE *Jubilee*

REGD. TRADE MARK

WORM DRIVE HOSE

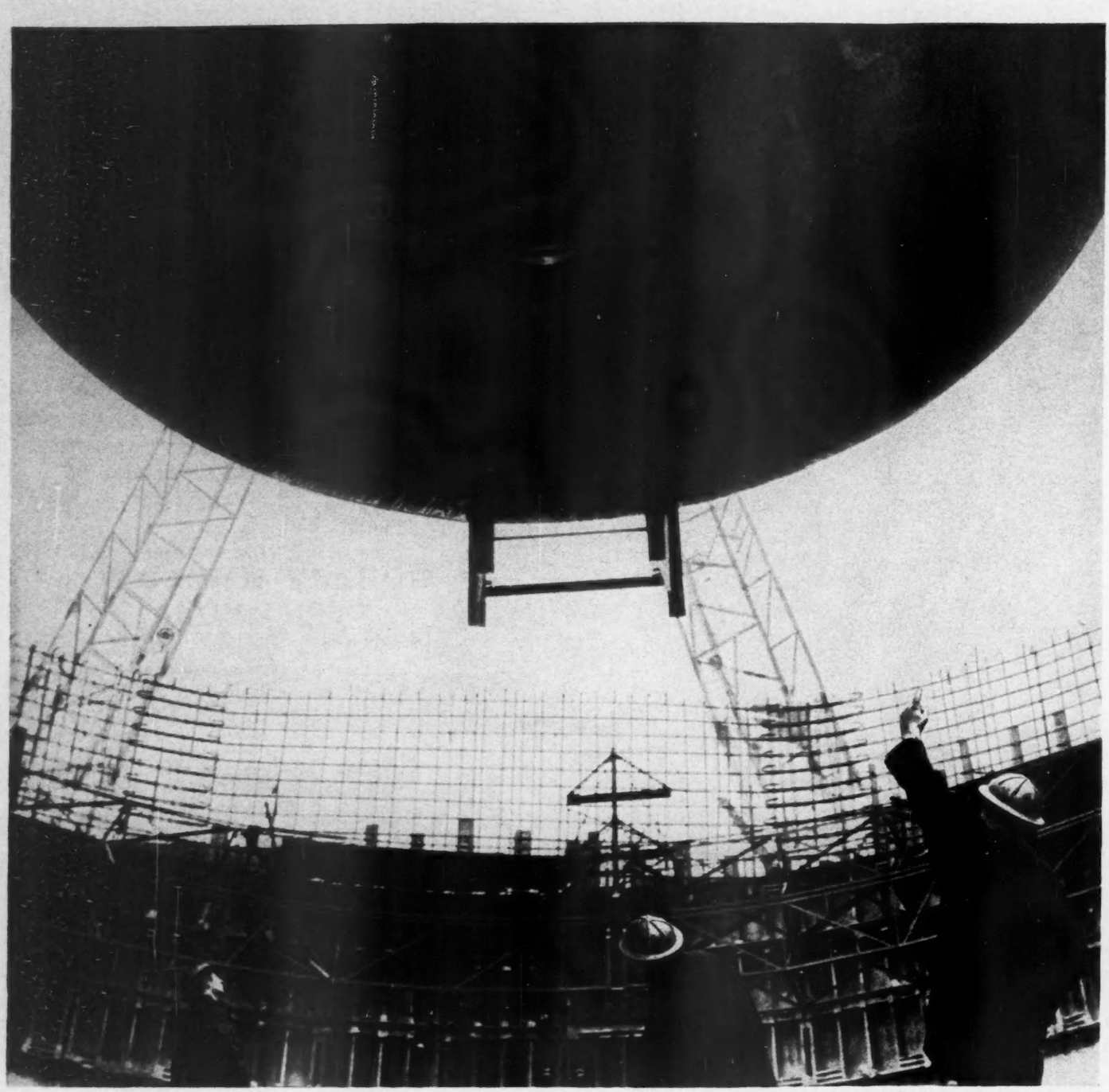
CLIP

The Finest Clip in the World

COMPANION ACCESSORY TO THE WORLD'S FINEST CLIP

L. ROBINSON & CO. (Gillingham) LTD.

LONDON CHAMBERS, GILLINGHAM, KENT TEL: 51182/3



The base of the reactor shell at Latina about to be lifted into position. (Photo by courtesy of AGIP Nucleare, Nuclear Power Plant Company and Whessoe Ltd.)

Atom power comes to Italy—and Consett's 'Bearcomo' steel is at the heart of it

ITALY'S first nuclear power station, at Latina, is being built by a British consortium (The Nuclear Power Plant Company Ltd.) and using British equipment and materials. The vital reactor shell, made by Whessoe Ltd., is of Consett's 'Bearcomo' steel.

Consett developed 'Bearcomo' specially for atomic reactors. Steel for this purpose has to have very good 'creep' resistance at high temperatures, and 'notch' toughness at low temperatures—two characteristics normally thought incompatible. 'Bearcomo' combines them.

Consett has provided special steels for Britain's own nuclear power programme. The reactors at Bradwell, Chapelcross and Calder Hall are housed in shells made of 'Bearcomo' plates. 'Bearcomo' was awarded a Gold Medal at the Brussels International Fair last year.

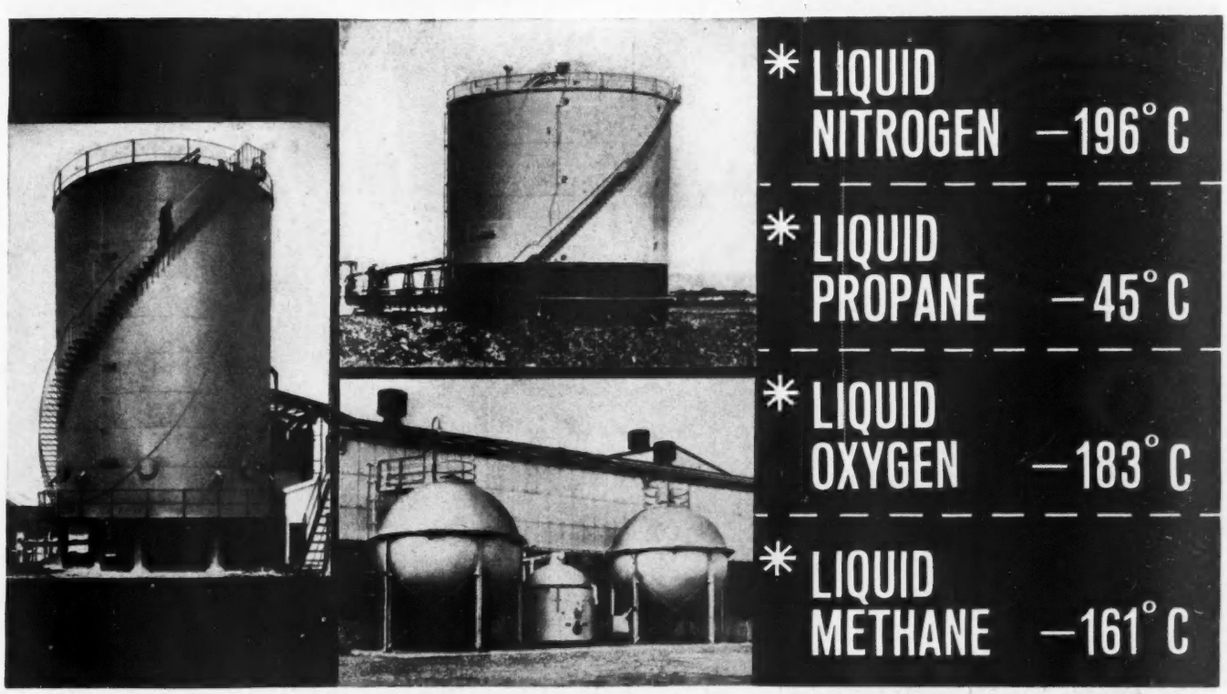
To keep its commanding competitive position in the field of steel plate, Consett is building a £14 million 'four-high' plate mill, which will be the most up-to-date in the world. Work on it is already well advanced: foundations are ready for the mill-stand itself and the great shears; the cooling tables and some of the transfer banks are finished, and the overhead cranes are installed. It will be a mighty addition to Britain's industrial power.

CONSETT
IRON COMPANY LIMITED

CONSETT, COUNTY DURHAM · TELEPHONE: CONSETT 341 (12 LINES) · TELEGRAMS: "STEEL PHONE CONSETT"

WHESSOE

FOR BULK STORAGE OF LIQUEFIED GASES*



The first 1,000 ton liquid methane tank to be used in this country, insulated and double skinned storage spheres and tanks for liquid oxygen and liquid nitrogen, are examples of the experience and skill of Whessoe in designing and building large tanks or vessels for the bulk storage of liquid gases at extremely low temperatures.

If you have a project which requires the low temperature storage of gases in bulk, consult Whessoe.

WHESSOE

DESIGNERS AND FABRICATORS OF CHEMICAL & ALLIED PLANT

WHESSOE LIMITED · DARLINGTON and LONDON · Tel: Darlington 5315 · ABBey 3881

CHWR/W/132

CZECHOSLOVAK MACHINERY— GUARANTEE OF GOOD QUALITY CERAMIC PRODUCTS

We design, produce and deliver complete equipment for ceramic works, i.e., porcelain factories, ceramic factories and factories for the production of refractory goods, etc., according to the needs of the Clients.

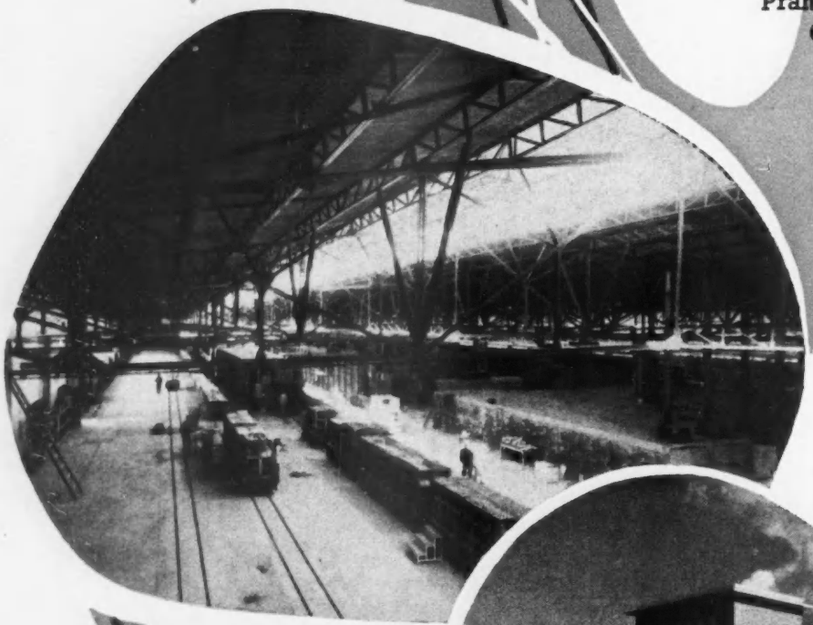
The Czechoslovak design meets all the requirements of existing technical standards for ceramic factory equipment and machines. If required, we are ready to give technical assistance by training the personnel who will attend and operate the equipment. The continually growing number of orders from abroad proves the high standard of Czechoslovak equipment.

TECHNOEXPORT

Foreign Trade Corporation for Export of Complete Industrial Plants

Praha 2 Václavské nám. 56

CZECHOSLOVAKIA



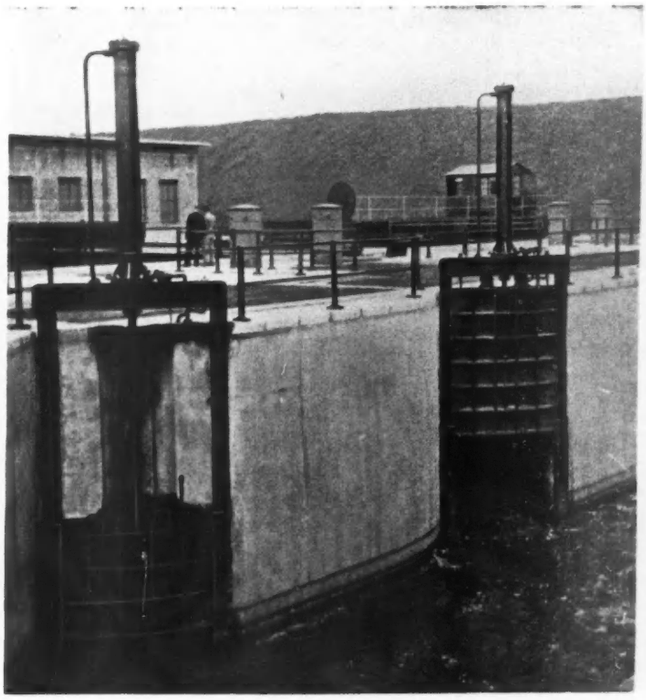
Visit our display stands at the Brno International Trade Fair, 11th—25th September, 1960.

TECHNOEXPORT

PRAHA CZECHOSLOVAKIA

GLENFIELD
Single Faced Sluices

for Water and Sewage Works, Thermal Power Stations, Land Drainage Schemes.



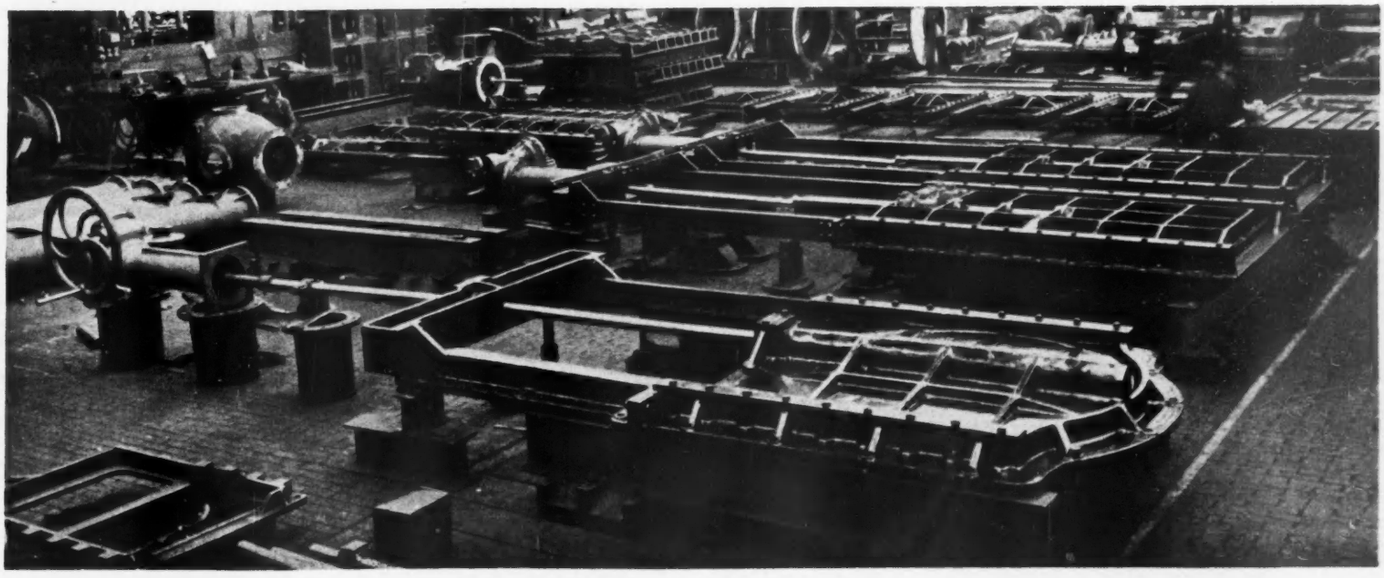
Available in two styles: an orthodox pattern for wall mounting or installation in open channels, and a dry-well version for culverts.

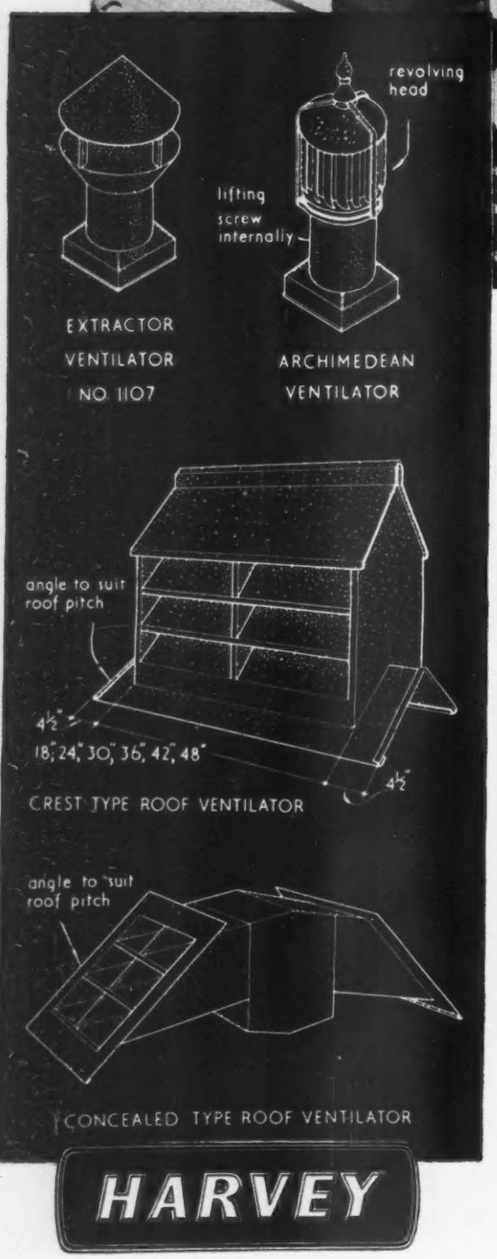
Both types are robustly constructed of MEEHANITE iron with bronze trim, and can be supplied for operation by manual, electric or hydraulic power.

The illustrations show large hydraulically driven units in a sewage purification works, and a variety of hand and electrically actuated units in course of manufacture.

Glenfield
GLENFIELD & KENNEDY LIMITED KILMARNOCK

Head Office and Works:
KILMARNOCK · SCOTLAND





"Natural" extraction of stale air is effective, economical and trouble-free.

'Harco' Self-acting Extractor Ventilators use the action of wind across specially designed louvres to induce a powerful upward suction movement of air, and at the same time prevent down draught. Allied to a correctly calculated number of air inlets, this type of "natural" ventilation will effect the changes of air required by normal conditions without recourse to mechanical forms of extraction. All ventilators are craftsman-made in zinc or mild steel, and can be supplied with or without roof seating as required.
Details are in our Catalogue No. 924; and we will readily advise on and suggest a suitable form of ventilation for any type of structure.

'HARCO' SELF-ACTING EXTRACTOR VENTILATORS

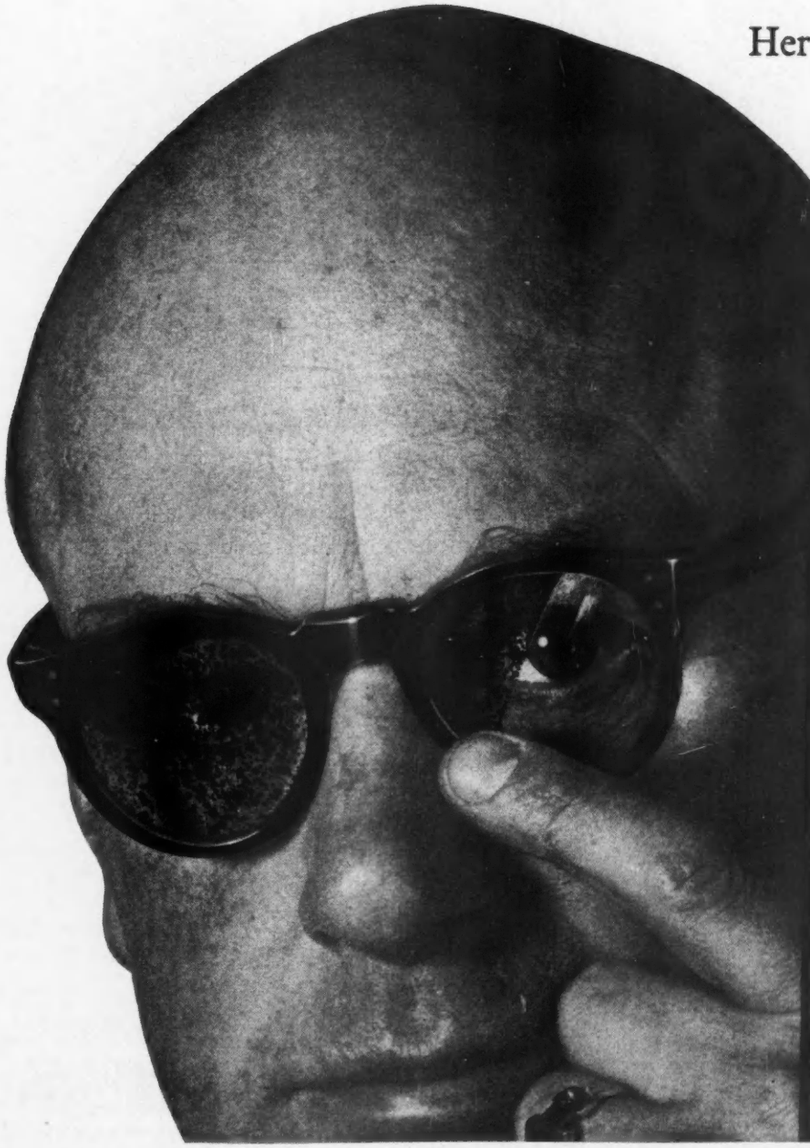
G. A. HARVEY & CO., (LONDON) LTD., WOOLWICH ROAD, LONDON, S.E.7.
Telephone: GREenwich 3232 (22 lines)

HARVEY Products for the Building Industry include:—
CHIMNEYS AND COWLS · OIL STORAGE TANKS · RAINWATER GOODS IN MILD STEEL AND ZINC · STORAGE BINS · STOVE PIPES AND FITTINGS · TANKS, CISTERNS AND CYLINDERS — DIRECT AND INDIRECT · WEATHER VANES · WIREWORK PRODUCTS
SM/10

see us for dust

For over 40 years we've been putting industrial dust safely out of the way before it can harm men or machines. In that time we've made a number of major contributions in our field—the development of the unit dust collector, for instance. We've made tens of thousands of them. Here is one of the very latest range . . .

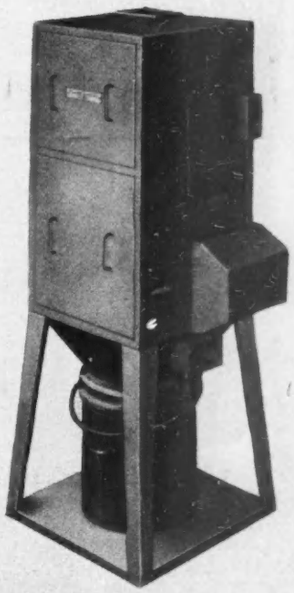
DALLOW LAMBERT



. . . . Meet the new

DALLOW LAMBERT Unimaster

It's the finest dust control unit in the world. It's compact, powerful and made in a range of sizes —70 to 250 sq. ft. of filter area. Fans, filters and dust containers are made in a range of interchangeable sizes, giving a tremendous flexibility of application.



Finally—NO MORE HAND SHAKING!

Every Unimaster incorporates our new 'push button' filter cleaning method.

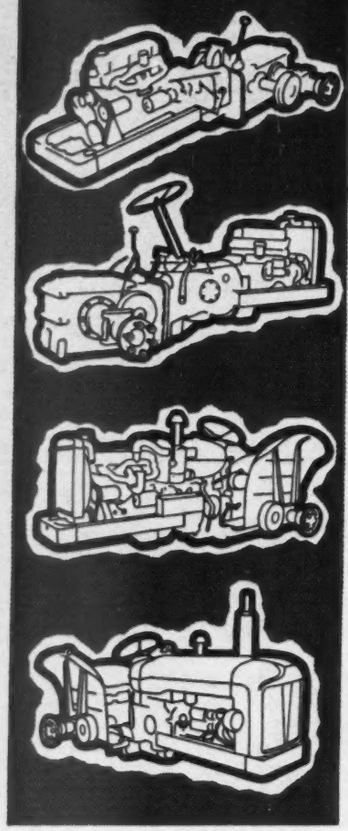
Whatever your industry you ought to know more about the UNIMASTER. Write or phone for further information.

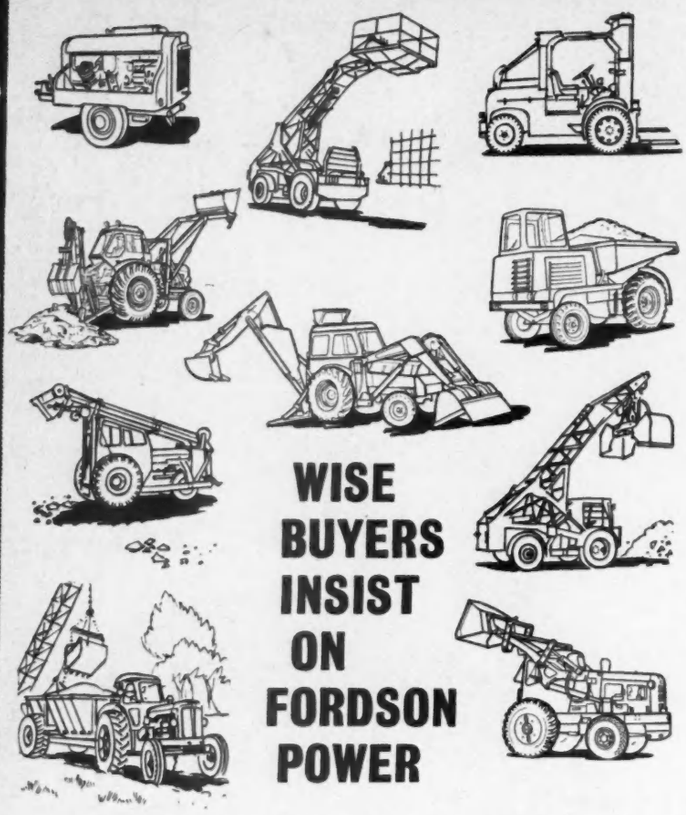
DALLOW LAMBERT & COMPANY LIMITED · THURMASTON · LEICESTER · TELEPHONE: SYSTON 3333 (7 LINES)

CRC 90

TOP DESIGNERS *INSIST* ON FORDSON POWER

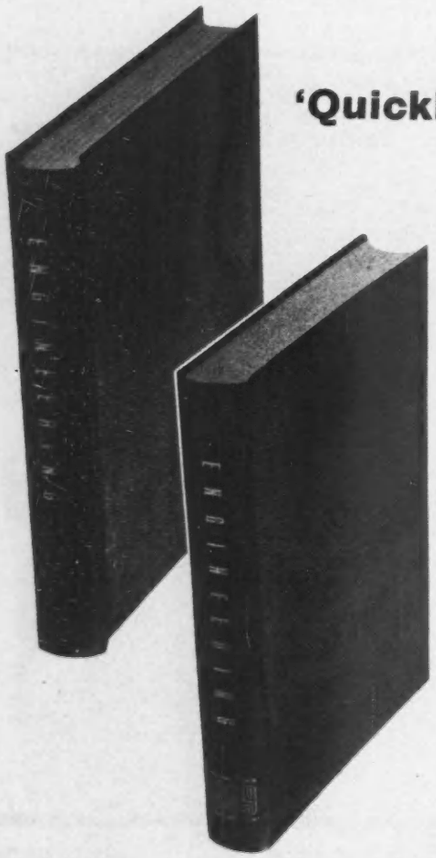
Britain's top designers of industrial machinery choose more Fordson power units than any other. For very good reasons too . . . proved reliability, high output at low cost in the toughest conditions, almost unlimited choice of build-ups in the 30-40 b.h.p. and 40-50 b.h.p. classes, and the backing of the Fordson world-wide service and spares organisation. And all with the low costs that come from quality, volume production in the great Dagenham plant. Write for detailed specifications.





WISE BUYERS INSIST ON FORDSON POWER

INDUSTRIAL SALES DEPARTMENT TRACTOR DIVISION FORD MOTOR COMPANY LIMITED DAGENHAM ESSEX



'Quickbinde' and Permanent-Binding Cases

The "Quickbinde" and permanent-binding cases are designed to reflect the contemporary character of the front cover and editorial pages of "Engineering".

Extreme left: the improved "Quickbinde", finished in dark green with washable covers. Lettering blocked in silver. Takes one volume of "Engineering" editorial pages or six issues complete with advertisements. Pages secured by three spring clips. Price 18s. 6d. post paid. Pair of levers (for first binder only) 9d. extra.

Left: the permanent-binding case for a volume of editorial pages. Finished dark green in washable durable material; lettering, volume number and months, and year blocked in silver. Prices: one case 17s. 6d. post paid; supplying one case and binding your pages 52s. 6d. post paid. When ordering, please specify volume number and dates.

Orders and remittances to "Engineering" 36 Bedford St. Strand, London, W.C.2. (Telephone: TEMple Bar 3663)

ENGINEERING

Free! Sample Tube of MOLYKOTE® G LUBRICANT

Industry's NEWEST Production TOOL

- ALMOST 100% SAFETY AGAINST GALLING AND SEIZING WITH ALL BEARING METAL COMBINATIONS
- ELIMINATES STICK-SLIP, METAL PICK-UP AND DISTORTION IN PRESS FITTING
- REDUCES WEAR-IN TIME AND DAMAGE IN NEW OR REBUILT MACHINERY
- THE HIGHER THE LOADS, THE GREATER THE MARGIN OF SUPERIORITY OF MOLYKOTE G

HIGHLY RECOMMENDED FOR:

- Threaded Connections
- Press Fitting
- Splines
- Highly-Loaded Gears
- Chucks & Collets
- Packings
- Drills, Taps & Dies
- Universal Joints
- Rod End Bearings
- Cams
- Dies & Punches
- Guide Posts

Write for your free sample of MOLYKOTE G LUBRICANT today. We will also send you a copy of our new Bulletin 126 which gives complete details.

AFSA LTD. 25, VICTORIA ST., LONDON S.W. 1

Please send me a free sample of your MOLYKOTE G Lubricant.

NAME _____

TITLE _____

COMPANY _____

_____

ADDRESS _____

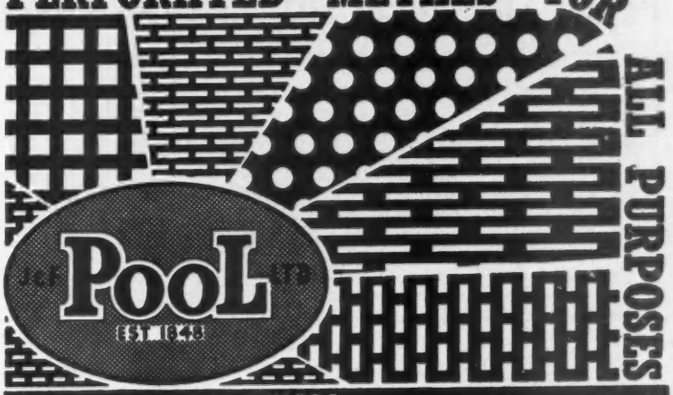
CITY _____

AFSA LTD.
25, Victoria St., London S.W. 1

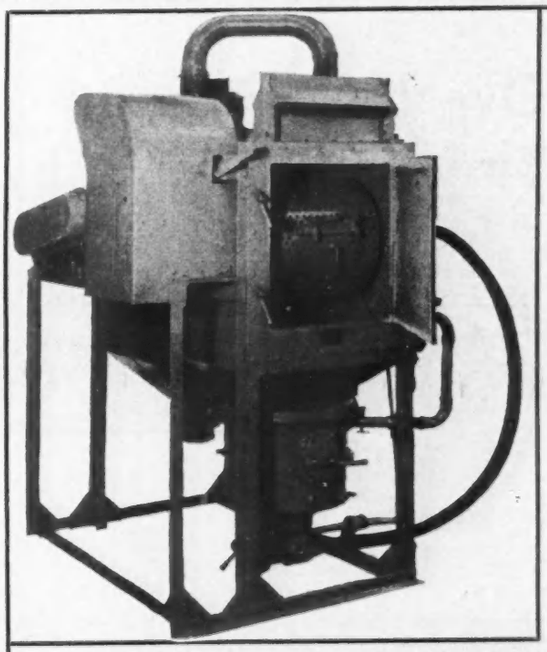
Valves, Cocks & pipe line fittings from Stock

PEGLER & LOUDEN LTD
54 BROWN STREET GLASGOW
113 NEW BRIDGE STREET NEWCASTLE
87 SHAW STREET LIVERPOOL

PERFORATED METALS FOR ALL PURPOSES



HAYLE, CORNWALL Tel. Hayle 3213



J. W. JACKMAN & Co. Ltd.

SHOT BLAST BARREL

COMBINED WITH FABRIC SCREEN FILTER, FAN AND ABRASIVE CLEANER. ALL ABOVE FLOOR LEVEL.

Fan and Barrel are independently motor driven so that Fan can run constantly.

FOR CLEANING SMALL AND MEDIUM SIZE CASTINGS, FORGINGS, PRESSINGS, STAMPINGS, Etc

J. W. JACKMAN & COMPANY LTD.

VULCAN WORKS, BLACKFRIARS RD., MANCHESTER, 3

Telephone: DEANSGATE 4648 (three lines) Telegrams BLAST, MANCHESTER

Serving Industry in every Capacity

These are two stainless steel Surge Tanks, 7 ft. 0 in. dia. by 6 ft. 9 in. long, each with a tubular centre shaft and 4 paddles. Yet another example of Booth's supreme versatility in welded steelwork.

BOOTH

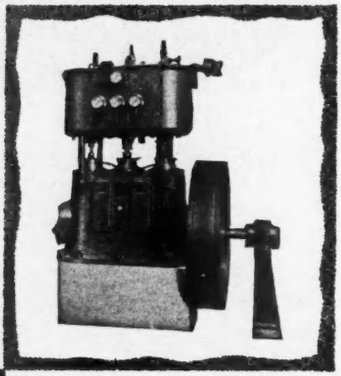
JOHN BOOTH & SONS (BOLTON) LTD., HULTON STEELWORKS, BOLTON. *Telephone:* BOLTON 1195. LONDON OFFICE: 26 VICTORIA STREET, LONDON, S.W.1. *Telephone:* ABBey 716.

JOHN FRASER & SON LTD.
FERRY STREET, MILLWALL, LONDON, E.14

Makers of
PRESSURE VESSELS
•
IMPREGNATORS and VULCANIZERS

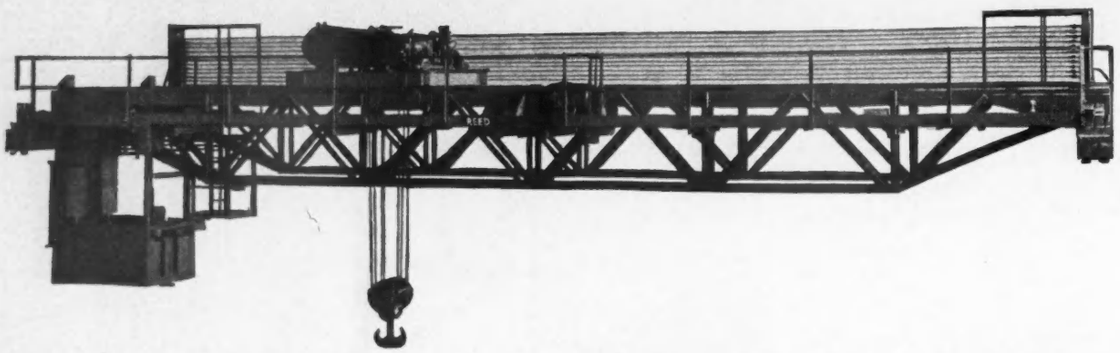
Telephone: EAST 1185 *Telegrams:* PRESVESALS, PHONE LONDON

COMPRESSORS
for
HIGH PRESSURES
and
SPECIAL GASES



SEAGERS
LIMITED · DARTFORD
KENT · ENGLAND
DARTFORD 3248

Overhead Electric Travelling Cranes by **REED**



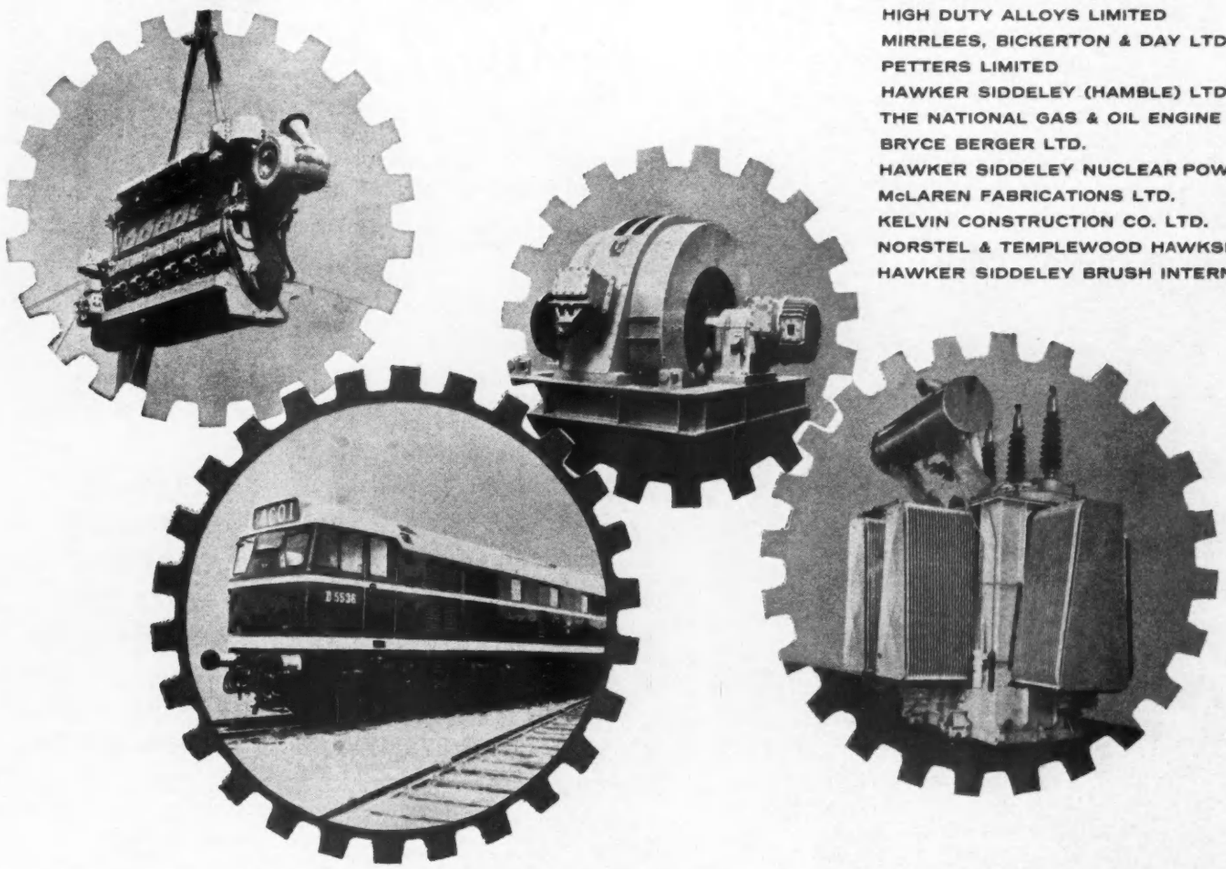
E.O.T. Cranes up to 50 tons S.W.L. and 100ft. span
Electric Hoists up to 15 tons S.W.L.
Jib Cranes, Goliath Cranes,
Winches, Telphers & Runways

Full Catalogue sent on Request

Reed Crane and Hoist Company Limited
Lodge Causeway, Fishponds, Bristol. Telephone: 65-3237/8 Bristol

A GUIDE TO HAWKER SIDDELEY INDUSTRIES LIMITED

BRUSH ELECTRICAL ENGINEERING CO. LTD.
FULLER ELECTRIC LIMITED
HAWKER SIDDELEY BRUSH TURBINES LTD.
HIGH DUTY ALLOYS LIMITED
MIRRLEES, BICKERTON & DAY LTD.
PETTERS LIMITED
HAWKER SIDDELEY (HAMBLE) LTD.
THE NATIONAL GAS & OIL ENGINE CO. LTD.
BRYCE BERGER LTD.
HAWKER SIDDELEY NUCLEAR POWER CO. LTD.
McLAREN FABRICATIONS LTD.
KELVIN CONSTRUCTION CO. LTD.
NORSTEL & TEMPLEWOOD HAWKSLEY LTD.
HAWKER SIDDELEY BRUSH INTERNATIONAL LTD.



Wherever power is needed—and in whatever form—this great Industrial enterprise is supplying a full range of equipment and engineering skills to meet the world's demands.

INDUSTRIAL, LOCOMOTIVE AND MARINE ENGINES · DIESEL, GAS, DUAL-FUEL, PETROL AND VAPORIZING OIL ENGINES · FREE PISTON GASIFYERS · PUMPING AND COMPRESSOR SETS; DIESEL-ELECTRIC GENERATING SETS · FUEL INJECTION EQUIPMENT; HYDRAULIC ENGINE STARTERS · STEAM, FREE-PISTON, INDUSTRIAL COMBUSTION GAS TURBINES AND TURBO-ALTERNATORS; TURBOCHARGERS.

ELECTRICAL POWER GENERATING PLANT · SWITCHGEAR; ELECTRICAL ROTATING MACHINES · DIESEL-ELECTRIC LOCOMOTIVES; TRACTION EQUIPMENT · DISTRIBUTION POWER AND MINING TRANSFORMERS · ON-LOAD TAP CHANGERS; VARIABLE SPEED A.C. COMMUTATOR MOTORS · DIESEL-ELECTRIC MARINE PROPULSION; RAILWAY CONTROL SYSTEMS; ELECTRONIC EQUIPMENT · ELECTRIC POWER TRACK · ELECTRICAL INDUSTRIAL VEHICLES.

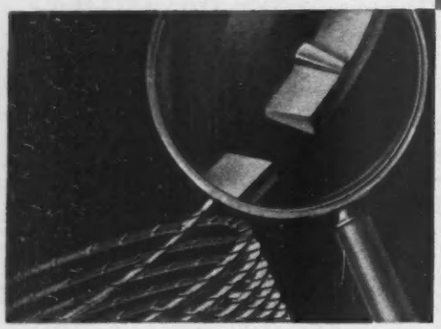
NUCLEAR REACTORS FOR RESEARCH AND MARINE PROPULSION · REFRIGERATION UNITS FOR ROAD TRANSPORT · FERROUS AND NON-FERROUS FORGINGS AND STAMPINGS; CASTINGS, EXTRUSIONS AND SHEET IN ALUMINUM ALLOYS · BUILDING AND CIVIL ENGINEERING, WELDED STRUCTURES, SCAFFOLDING, CURTAIN WALLING, SEWAGE INSTALLATION AND VENTILATING EQUIPMENT.

HAWKER SIDDELEY INDUSTRIES LTD. INDUSTRIAL DIVISION OF THE HAWKER SIDDELEY GROUP 32 Duke Street, St. James's, London, S.W.1

A full range of SUCTION TYPE FILTERS

Here is a full range of six standard size metal edge filters designed for immersion in a tank or casing on the suction side of any system applicable to cutting oils, hydraulic fluids, light machine oils, etc.
They are permanent, cleanable filters, efficient and reliable in action.

Six SIZES FROM 2 g.p.m. TO 35 g.p.m.

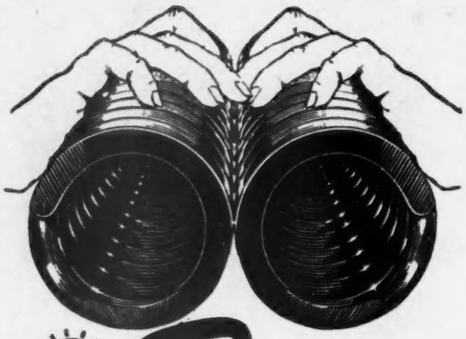


Purolator metal edge filters consist of a patented edge-wound metal ribbon of tapering cross-section that presents a rigid surface to the incoming fluid. The precision formed ribbon is closely wound under tension on to a supporting frame and securely fixed at each end. Projections on the ribbon, which are of uniform height and formed at defined intervals along its surface, give a degree of filtration from ·002" to ·020" as required. These filters can be supplied in brass, monel metal or stainless steel materials.

PUROLATOR
REGD. TRADE MARK
METAL-EDGE FILTERS

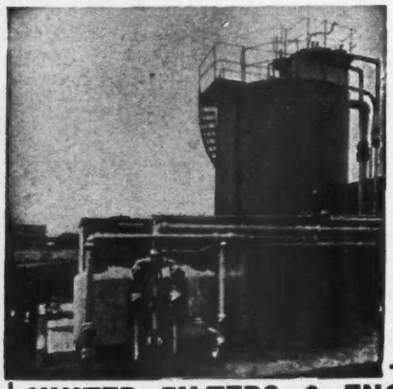
AUTOMOTIVE PRODUCTS COMPANY LTD
LEAMINGTON SPA, WARWICKSHIRE, ENGLAND
ONE OF THE AUTOMOTIVE PRODUCTS GROUP

Looking in the right direction



Ratcliffe SPRINGS

F. S. RATCLIFFE (ROCHDALE) LTD.,
Crawford Spring Works, Norman Road, Rochdale
Phone: Rochdale 40415 'Grams: Recoil, Rochdale
Telex No: 63178 CW5968/1



Water Treatment

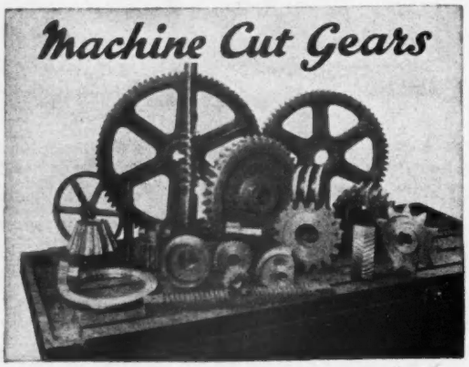
•

FILTRATION
CLARIFICATION
SOFTENING
BOILER FEED
CONDITIONING, Etc.

UNITED FILTERS & ENGINEERING LTD.
WATER TREATMENT SPECIALISTS—LONDON, S.W.15.

Phone: PUTney 4441 Telegrams: Unifilters, Put. London

Machine Cut Gears

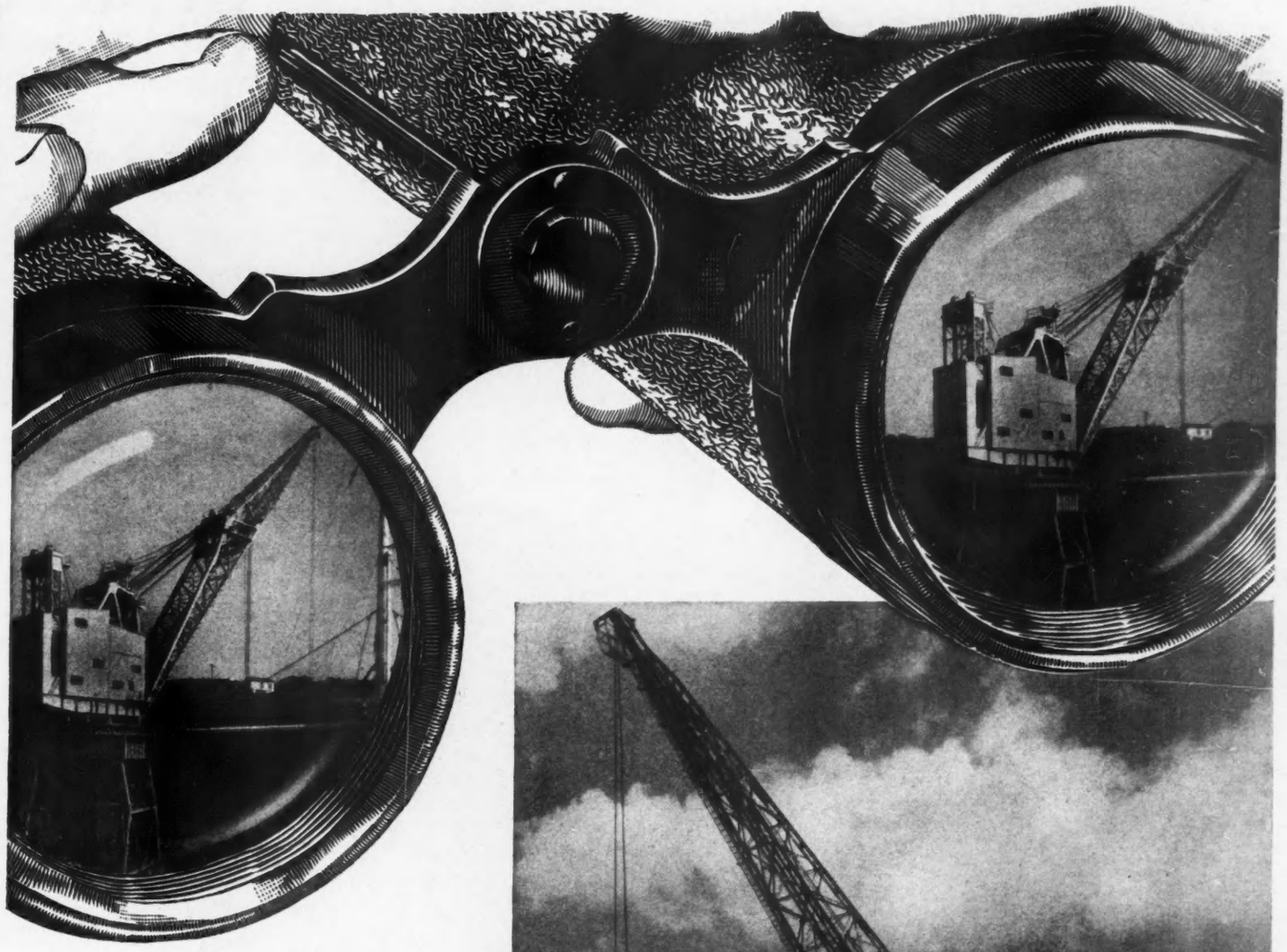


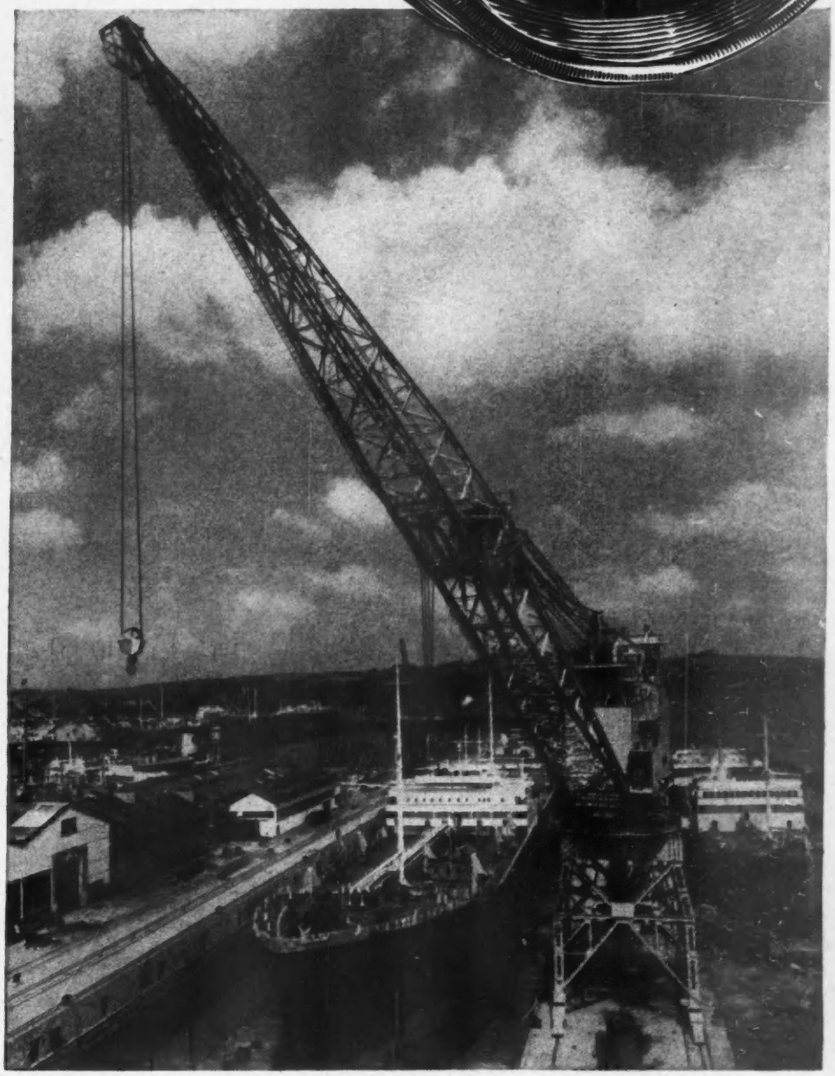
SPURS
BEVELS
WORM WHEELS
WORMS
RACKS
CHAIN WHEELS
HELICALS
SCREWS
SILENT GEARS

COMPLETE SUPPLY OR CUTTING ONLY TO 7 FEET DIAMETER

General Machine Castings made to customers' Patterns. Low Prices for Planing, Boring, Turning, Screwcutting

Send your enquiries to:—
GREENWOOD'S STANDARD GEAR CUTTING CO. LTD.
New Bond Street, Halifax. Telephone: Halifax 5217/8 Telegrams: "Gears"





Focus on Falmouth

A new Falmouth landmark visible from far at sea is this 247 ft. high Stothert & Pitt crane built for Messrs. Silley, Cox & Co. Ltd. It is one of the largest balanced rope level-luffing cranes in the country and can lift up to 61 tons at 105 feet radius. Ward Leonard hoist drive ensures precise control on both main and auxiliary hooks.

The 175 ft. maximum working radius enables 12-ton loads to be picked up from the far side of the new Queen Elizabeth Dry Dock which accommodates vessels up to 85,000 tons.

For a hundred years the name "Stothert & Pitt" has been linked with all that is best in crane design—a reputation to which this crane at one of Britain's most modern dry docks adds fresh lustre.

S&P LIMITED

STOTHERT & PITT LIMITED

ENGINEERS · BATH · ENGLAND

London Office: 38 Victoria Street, S.W.1

Midlands Office: Gt. Western Bldgs., 6 Livery Street, Birmingham 3

SP108

DESIGNED TO USE ARALDITE

By designing for Araldite, South Wales Switchgear Ltd. have provided adequate protection for this 3-phase voltage transformer without the use of oil. The coils and insulators form a single casting of Araldite B, simple in design and easy to manufacture. Araldite casting resins do not shrink on setting, and are thereafter unaffected by very wide changes of temperature and humidity. Their properties also include remarkable adhesion to metals, ceramics, etc., high mechanical strength, freedom from chemical action and excellent dielectric properties.

Araldite
Araldite is a registered trade name

epoxy resins

Araldite epoxy resins are used

- **for casting high grade solid insulation**
- **for impregnating, potting and sealing electrical windings and components**
- **for producing glass fibre laminates**
- **for producing patterns, models, jigs and tools**
- **as fillers for sheet metal work**
- **as protective coatings for metals, wood and ceramic surfaces**
- **for bonding metals, ceramics etc.**

May we send you further details?

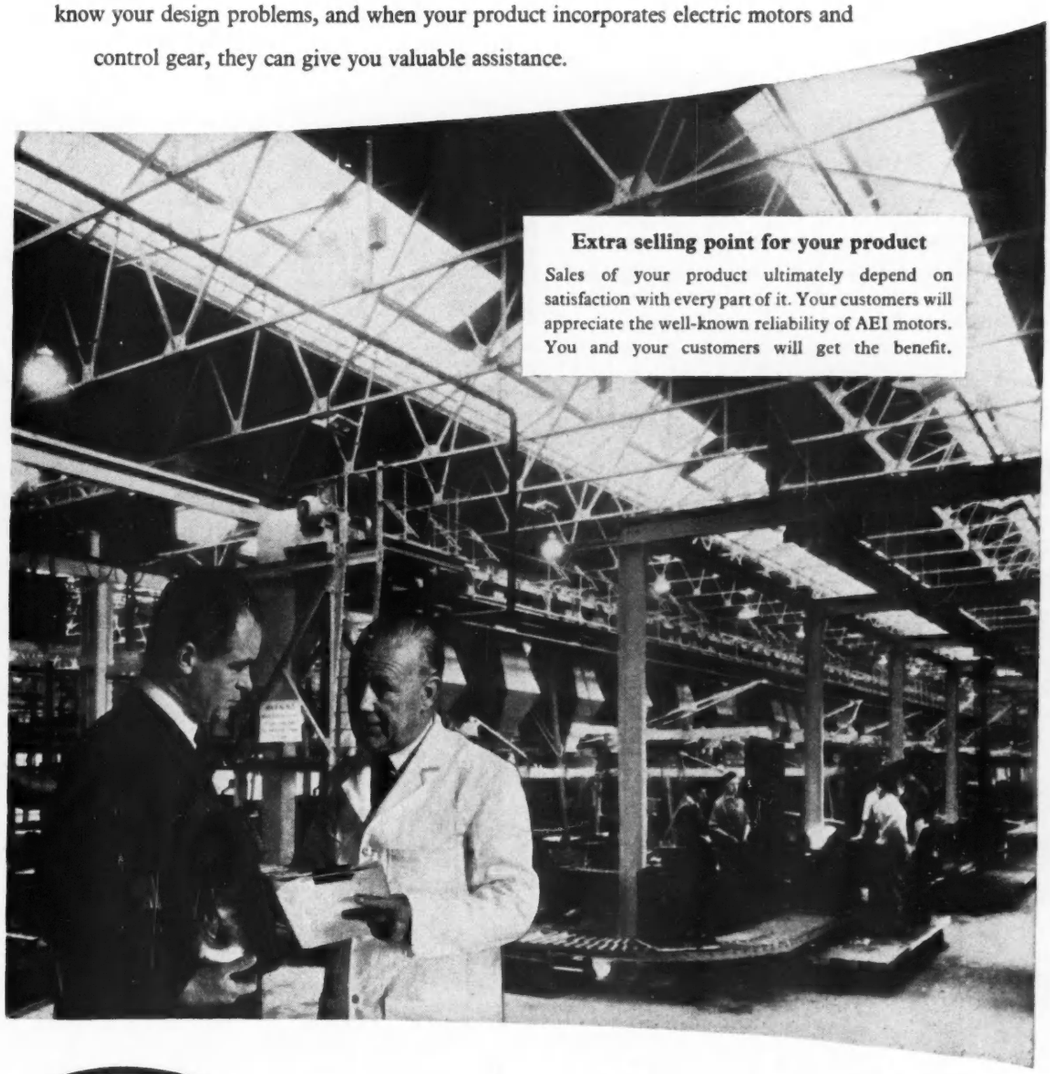
CIBA (A.R.L.) LIMITED *Duxford, Cambridge : Telephone: Sawston 2121*

AP464

Printed by HARRISON & SONS, LTD., by Appointment to H.M. The Queen, Printers, London, England. Published by ENGINEERING LTD., at 36 Bedford Street, London, W.C.2

AEI Engineers talk his language...and YOURS

Whether the eventual user of your product is an ironfounder or a farmer, whether he manufactures cars or bakes bread, you will find that AEI understands his particular requirements. Up-to-the-minute thinking on user preference means that AEI engineers know your design problems, and when your product incorporates electric motors and control gear, they can give you valuable assistance.



Extra selling point for your product

Sales of your product ultimately depend on satisfaction with every part of it. Your customers will appreciate the well-known reliability of AEI motors. You and your customers will get the benefit.

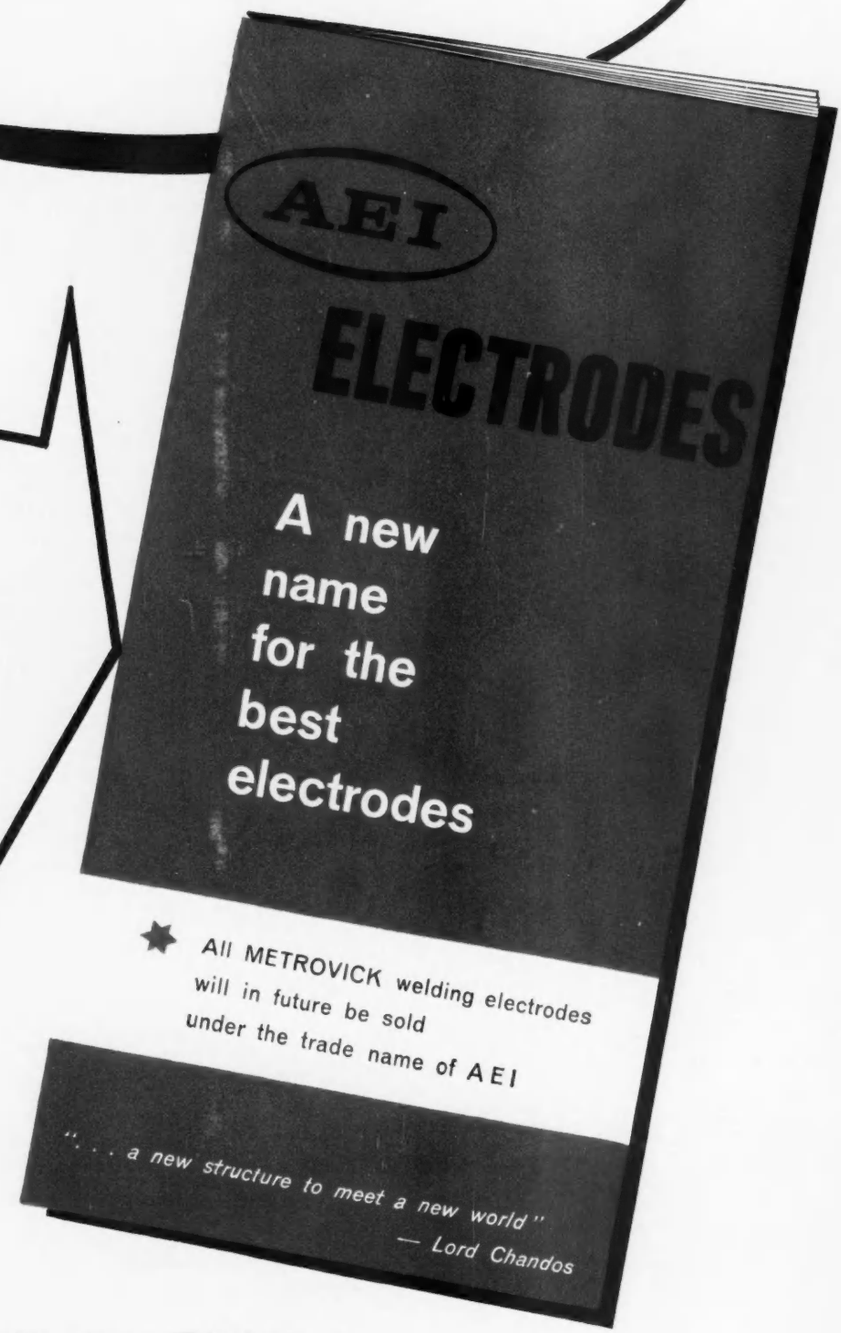
AEI

Associated Electrical Industries Limited
Motor and Control Gear Division
RUGBY & MANCHESTER, ENGLAND

INCORPORATING THE MOTOR AND CONTROL GEAR INTERESTS OF BTH AND M-V

A5419

Electrodes worthy of the welder


AEI
ELECTRODES
A new name for the best electrodes
All METROVICK welding electrodes will in future be sold under the trade name of AEI
". . . a new structure to meet a new world"
— Lord Chandos

SEND FOR YOUR COPY TODAY

This new edition of the Pocket Electrode Guide provides full technical information on the complete range of AEI electrodes. There are over 50 pages of useful facts and figures. May we send you a copy?

AEI

Transformer Division
Heating and Welding Department
TRAFFORD PARK • MANCHESTER 17
Associated Electrical Industries Limited

L/P902